DOCUMENT RESUME

ED 309 313 CE 052 971

AUTHOR Immel, Michael C.; Geroy, Gary D.
TITLE Needs Assessment for Curriculum Design and Development in the Powdered Metals Industry. Project Number One.
INSTITUTION Pennsylvania State Univ., University Park. Inst. for Research in Training and Development.
PUB DATE May 87
NOTE 65p.
PUB TYPE Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS Adult Vocational Education; *Basic Skills; *Competency Based Education; Employee Attitudes; Employer Attitudes; Job Skills; *Metal Industry; *Metallurgy; *Needs Assessment; *Training

ABSTRACT

This study, which investigated industry-wide needs for training development in the powdered metals industry, identified the following knowledge areas as those most needed by workers: (1) basic reading and communication skills; (2) basic and algebra mathematical skills; (3) blueprint reading; (4) statistical process control; (5) standard and precision measurement; and (6) machine set-up, operation, and maintenance. (The preceding list is prioritized, with the area listed as 1 being the most frequent response of the combined data.) The data were collected through administration of a desired skill and knowledge instrument to employees and managers at 24 powdered metals manufacturers in six counties in north central Pennsylvania and through structured interviews with the managers. Minor discrepancies of less than 10 percent were identified between the ratings of employees and managers concerning the knowledge areas of blending, sintering, and tumbling (a need for which employees rated higher than did managers) and hydraulics and pneumatics knowledge of presses (the need for which managers rated higher than employees). The bulk of the document is appendices containing copies of the interview questions asked of managers, the employee survey, one-way analysis of variance tables, and pie and line charts reporting the data on each knowledge area. (CML)

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ED309313

Project Number One

Needs Assessment for Curriculum Design and Development in the Powdered Metals Industry

Michael C. Immel
Gary D. Geroy

May 1987

Institute

for

Research in Training and Development

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INTRODUCTION

In January 1987, Ben Franklin Partnership Program awarded North Central Pennsylvania Regional Planning and Development Commission (NCPRPDC) a grant to undertake the project of "Curriculum Design and Development for Powder Metals Industries." NCPRPDC collaborated with The Pennsylvania State University's Division of Counseling and Educational Psychology and Career Studies to address the assessment of training needs in the Powdered Metals Industry. This report contains the strategic plan and rational applied to the study, along with the specific tools utilized to achieve valid conclusions as developed by Michael Immel with the technical assistance of Dr. Gary D. Geroy. The final portion of this report will be the synthesis of the data and the implications of the results which can assist NCPRPDC in curriculum design and development for the industry's needs. Involved in this study are:

Arthur Heim, Director, Training and New Business, Ben Franklin Partnership Program

Donald Masisak, Deputy Director, North Central Pennsylvania Regional Planning and Development Commission

Michael Lawrence, Director, Job Training Partnership Act

Karen Dickinson, Curriculum Coordinator, North Central Pennsylvania Regional Planning and Development Commission

Dr. Gary D. Geroy, Assistant Professor, Division of Counseling and Educational Psychology and Career Studies, The Pennsylvania State University

Michael Immel, Graduate Assistant, Division of Counseling and Educational Psychology and Career Studies, The Pennsylvania State University

Advisory Committee of Powdered Metals Industry representatives

The study was prompted in part because of the significant contribution of the Powdered Metals Industry to the economy of the six county region in which NCPRPDC services. Direct Powdered Metals Industries accounted for 16% of all people employed in the manufacturing sector of the region. In addition, the growth rate of Powdered Metals Industry was 22% from 1970-1983 and 9% from 1984-1986, which signifies a possible need for training in these industries.

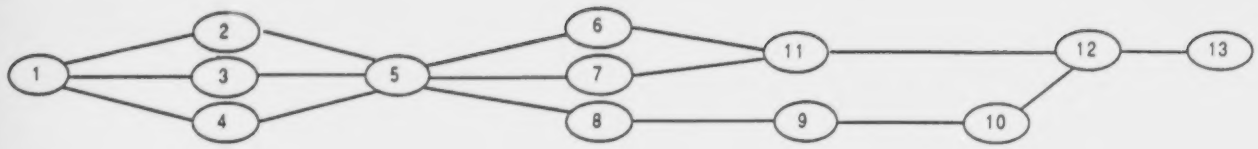
STRATEGIC PLAN AND RATIONAL

Needs assessment directed at curriculum design and development for a specific industry is the systematic identification and comparison of those specific knowledge and skill components desired by the industry and those possessed by the workers. The identification process involves the use of a variety of formal and non-formal forms of inquiry. Within the Powdered Metals Industry the general areas to be addressed in this study are production, quality control, and maintenance.

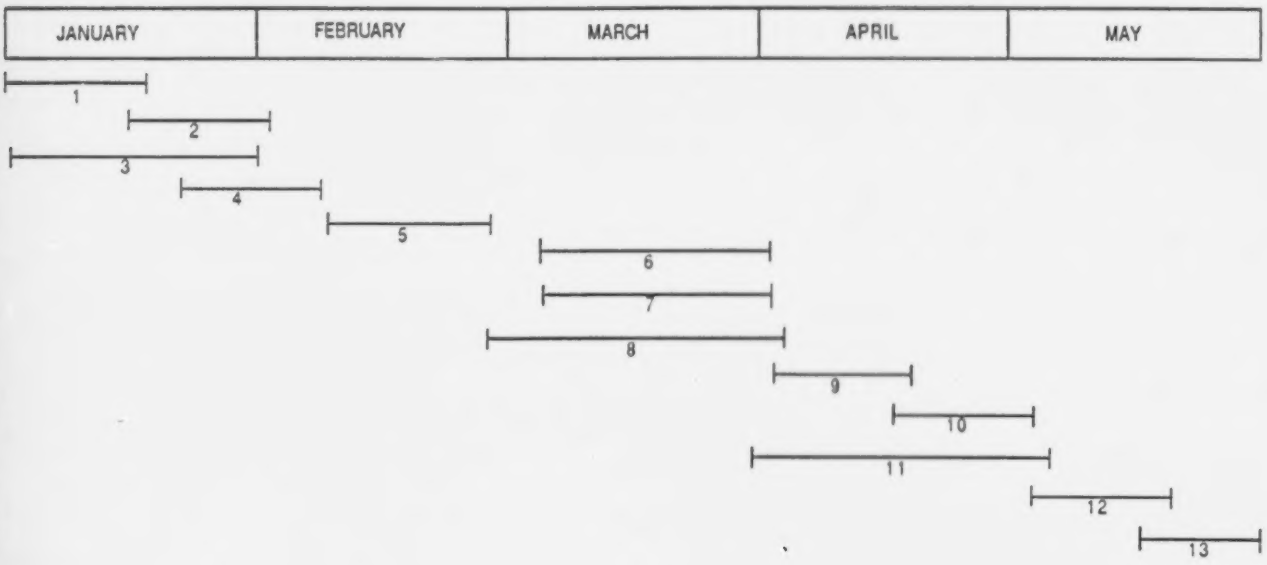
The strategy used in this study is outlined by the following pert chart. A detailed description of each step is provided for further clarification of the assessment plan. Found in Appendix A is a copy of the instruments used to collect data from participating manufacturers in the Powdered Metals Industry.

Constraints on Study

There were some major constraints of this study with the first and foremost being the fact that a study of this nature has never been systematically completed before to the knowledge of the authors. This constraint did not allow the researchers to study and learn from other efforts which could have guided them more easily through the study. The second constraint was the proprietary nature of the industry which consequently prevented the researchers from interviewing the actual workers but rather collect data through only using a survey instrument. Collecting data in this manner has possible drawbacks in analysis due to low return and non-validated results.



1. Design Study
2. Establish Stakeholder Group
3. Develop Desired Knowledge Instrument
4. Develop Structured Interview Instrument
5. Pilot Test Desired Skills Instrument
6. Conduct Data Gathering (Survey Form Developed)
7. Conduct Data Gathering (Interviewing)
8. Design Organization Assessment Instrument
9. Pilot Test Organization Assessment Instrument
10. Disseminate Instrument
11. Analyze Data
12. Synthesize Study
13. Write Final Report



STEPS

1. The design of this study is to assess all worker activities of the Powdered Metals Industry within a hierarchy of general and job specific knowledge and responsibilities. The format used is:

   Job Classification Identification

   Work Activity Classifications Identification

   Variables (generic or job specific) Identification

   Knowledge & Skill Elements Identification

   Competency Level Identification

   Required: Not Needed

   Nice to Know

   Ought to Know

   Need to Know

   Possessed: None

   Introductory

   Intermediate

   Expert

   Discrepancy Identification

   Training Solution Options Identification

   Training Solution Implementation

2. Identify a stakeholder group comprised of representatives from the Powdered Metals Industries to participate in an advisory capacity to the study.

3. Develop a desired knowledge and skill survey instrument by:

   a. Identifying the constraints and the data profile that will be addressed to carry out the study.

   b. Identifying the specific hierarchy of knowledge framework indigenous to the Powdered Metals Industry which will guide the study.

4. Develop a structured interview instrument by:
   a. Developing an issues profile and review with the stakeholder group for clarification, modification and endorsement.
   b. Finalize the instrument.
5. Pilot test the desired knowledge, skills and interview instruments with 10% of the industries for validation.
6. Conduct the data gathering of the desired knowledge and skills instrument by mailing the forms to each Powdered Metals manufacturer in the six county region.
7. Conduct the data gathering by interviewing with appropriate representatives of each Powdered Metals manufacturer using the structured interview instrument to ensure commonality of results.
8. Design the organization or employee assessment instrument from:
   a. Information collected from the desired skill and knowledge instrument that ought to be or needs to be known for worker activity.
   b. Results of the structured interviews with Powdered Metals Industry managers with respect to new employee, current employees, new technology, quality control, and cross-craft policies.
9. Pilot test the organization assessment instrument with 10% of the employee group for validation.
10. Disseminate the instrument to the managers of all the Powdered Metals Industry companies for distribution.
11. Analyze the data from each instrument to aid in the determination of relationships.
    a. Desired knowledge and skill instrument
    b. Structured interview instrument
    c. Organization assessment instrument

12. Synthesize the data analyzed to develop conclusions and implications of the study.
13. Write a final report and present finding to North Central Pennsylvania Regional Planning and Development Commission, Ben Franklin Partnership Program and participating industries.

ANALYSIS OF STRUCTURED INTERVIEW

Background

This data was collected through structured interviews of powdered metal manufacturing industries in the NCPRPDC servicing region. A copy of the interview questions can be found in Appendix A. The purposes of the interviews was to gain background information on the industry as a whole relating to organizational and employee demographics. Other pertinent information collected was prior and present training strategies utilized by the industry along with recommendations of possible training needs of the industry. Tangential information on quality control, production and maintenance departments was also collected for a more thorough understanding of these areas for the researcher's use in the synthesis of the study.

Findings

North Central Pennsylvania Regional Planning and Development Commission (NCPRPDC) identified 30 direct powdered metals manufacturers in the six county servicing region. They were contacted by Karen Dickinson and Michael Immel in April for participation in the project. Of the thirty identified, 24 participated in the interview data gathering portion of the study. The following information is the combined results of these 24 organizations with company identities withheld.

1. Organization demographics
    a. Four of the 24 participating companies work under union contracts with the other 20 not under any contractual obligations.
    b. Of the 24 industries interviewed 17 had less than 100 employees with the average company size being 35 full time employees.
    c. The remaining 7 companies had more than 100 employees with an average of 525 full time employees.

d. All of the companies, except two, indicated an expected increase in the current work force ranging from 5% to 200% over the next five years.

e. Of the two companies not anticipating an increase, one expected the number of employees to remain constant while the other expected a reduction in their workforce by 10% over the next five years.

2. Employee Demographics

a. The average age of powdered metals industry workers is as follows

26% under 30 years of age

41% between 30-40 years of age

22% between 40-50 years of age

11% over 50 years of age

b. The average educational level of employees as reported by managers

6% have less than a high school diploma

85% have a high school diploma

9% have more than a high school diploma

Of the 9% that has more than a high school education, 8% had some form of vocational training, with the remaining 1% with four year baccalaureate degrees.

3. Training strategies utilized and recommended training needs.

a. All of the participating organizations indicated involvement in employee training in the form of either structured, unstructured or a combination thereof. A further breakdown revealed that 100% of the companies used on-the-job training as a method or strategy for bringing new and/or transferred employees to a desired job performance level.

Less than 1% utilized structured in-house training programs. Also outside training programs and/or consultant training showed a less than 1% frequency rate among the 24 companies interviewed.

b. The training needs as reported by managers is listed below with the frequency of that particular response to the right of each need.

Basic Math Skills	4
Basic Reading Skills	5
Communication Skills	4
Problem Solving Skills	2
Conceptual Skills	1
Blueprint Reading Skills	11
Blueprint Drawing Skills	3
Standard and Precision Measure Skills	5
Following Directions	2
Motivational/Attitudinal Skills	3
Die Setting Skills	3
Machine Set Up Skills	2
Machine Shop Skills	2
Statistical Process Control Skills	11

4. Tangential information was also gathered on quality control, maintenance, and production which was then analyzed respectively.

a. Quality control data revealed that all powdered metals manufacturers interviewed had a quality control/assurance department with 67% currently using or implementing statistical process control. Five training strategies reported by the companies using or implementing SPC were training videos, customer training support,

Penn State University courses, and in-house training by formal and non-formal methods. Within the interviews several managers indicated that customers were increasingly requiring SPC data with purchased products.

b. Maintenance departments in the organizations varied in size from one general maintenance individual to several maintenance crews. All companies were asked to indicate whether their maintenance policy was interval, repair only, or both. Seventy-five percent of the companies used interval or preventive maintenance and repaired their own equipment when possible. The remaining 25 percent did maintenance on a repair only basis. Seventy-nine percent of the companies interviewed utilized the maintenance employees where needed as opposed to the 21 companies who had maintenance employees working specialized trades or individual crafts.

c. Production department data was collected on the condition of production machinery and whether production employees performed various jobs or only one specialized task. Managers reported the condition of their production equipment of either excellent, good, fair, or less than fair. Fifty-two percent rated equipment as good, 37% rated equipment as excellent and 11% rated their equipment as fair. Seventy-seven percent of the employees in production departments were reported to work where needed and able to perform various tasks, with 23% of production employees working at only one job.

ANALYSIS OF MANAGERS DESIRED SKILLED KNOWLEDGE INSTRUMENT

Background

This data was collected with a desired skill and knowledge survey which was disseminated to 24 powdered metal manufacturers indicating interest in the project. A copy of this instrument is in Appendix A of this report. The purpose of this survey was to identify what skills and knowledge managers desired of production, maintenance and quality control job classifications. Seventeen companies or 65% of the industries in the region completed and returned the forms for analysis.

Findings

The data from the survey was analyzed first by calculating the mean score of each knowledge element for individual companies. The mean data from all companies was then combined to determine the industry wide mean score for each knowledge element listed in the survey. A copy of this industry wide data is included in Appendix B for reference.

The scale or code used for the survey and analysis was

0 = not needed

1 = nice to know

2 = ought to know

3 - need to know

Using the industry wide desired knowledge data, a mean score of 1.0 or more was further analyzed with a pie chart, percent of responses, and a line chart showing each of the 17 companies' mean score without revealing company identity. A copy of this data for each element over 1.0 is found in Appendix B.

The following table shows the relationships of the knowledge elements showing a mean score of 1.0 or more.

Table 1

	1.0	1.5	2.0	2.5	3.0
Math					
Basic	----------]				
Algebra	----------]				
Reading Grade Levels					
6-7	----------]				
8-9	----------]				
9+	----------]				
Blueprint Reading	----------]				
Quality Control					
Standard Measurement	----------]				
Precision Measurement	----------]				
Statistical Quality Control	----------]				
Presses					
Hydraulics	----------]				
Pneumatics	----------]				
Machines					
Set Up	----------]				
Operation	----------]				
Maintenance and Repair	----------]				

ANALYSIS OF ORGANIZATION ASSESSMENT INSTRUMENT

Background

The data was collected with an employee survey distributed to the 24 powdered metals manufacturers participating in the structured interviews. A copy of the instrument is contained in Appendix A of this report. The objective of this survey was to reveal employee perceptions regarding knowledge elements needed or not needed for their job performance. Seven companies or 26% of the industries in NCPRPDC serving region returned the forms completed by a representative groups of employees.

Findings

The employee survey forms were analyzed in the same manner as the managers survey by first calculating the mean score of each knowledge element for individual companies. The mean data from each company was then combined to determine the industry wide mean of each knowledge element as perceived by powdered metals workers.

The scale used for the survey and analysis was

0 = not needed

1 = nice to know

2 = ought to know

3 = need to know

The mean scores are representative of the scale 0 to 3 indicating that a mean score close to 0 for knowledges was frequently not needed and that a mean score close to 3 was frequently needed for performance of job classifications in the Powdered Metals Industry. A copy of this industry wide mean data is included in Appendix C for closer examination.

Mean scores of knowledge elements higher than 1.0 was further analyzed using a pie chart, percentage of responses and a line chart showing each

of the seven companies' mean score without revealing company identity. A copy of this data is included in Appendix C for further reference.

The following table shows the relationship of the knowledge elements showing a mean score of 1.0 or more from the employee perceptions are

Table 2

	1.0	1.5	2.0	2.5	3.0
Math					
Basic	----------]				
Algebra	---------]				
Reading					
6-7	----------]				
8-9	----------]				
9+	----------]				
Blueprint Reading	----------]				
Quality Control					
Standard Measurement	----------]				
Precision Measurement	----------]				
Statistical Quality Control	----------]				
Metallurgy					
Physical Properties	-------]				
Blending	--------]				
Heat Treatment					
Sintering	----------]				
Finishing					
Tumbling	---------]				
Machines					
Set Up	----------]				
Operation	----------]				
Maintenance and Repair	----------]				

SYNTHESIS OF DATA

The analysis of the structured interview, managers desired skills and knowledge survey and the employee survey revealed areas that consistently appeared to be needed for job performance in powdered metals manufacturing. These areas were identified by comparing the industry wide mean data from both surveys and considering the responses of managers in the structured interview showing similarities or discrepancies. Below is a list of the knowledge elements that consistently scored high in terms of needed to know for job performance. These identified areas are prioritized with number 1 being the most frequent response of the combined data.

1. Basic reading and communication skills
2. Basic and algebra mathematical skills
3. Blueprint reading
4. Statistical process control
5. Standard and precision measurement
6. Machine set up, operation and maintenance

According to the data gathered these trends exist as a representation of industry wide needs for possible training development.

No major discrepancies were revealed in the knowledge data. Minor discrepancies of less than 10% were identified in the areas of blending, sintering, and tumbling with employees rating the need for these knowledges higher than managers. Hydraulics and pneumatics knowledge of presses was an area managers rated higher than employees but also showed less than a 10% discrepancy.

IMPLICATIONS AND RECOMMENDATIONS

Implications or suggestions for training curriculum design and development in the Powdered Metals Industry would be in the six areas identified in the synthesis.

1. Basic reading and communication skills
2. Basic and algebra mathematical skills
3. Blueprint reading
4. Statistical process control
5. Standard and precision measurement
6. Machine set up, operation and maintenance

A recommended curriculum should be developed to address powdered metal employees from any job classification. Some considerations to be given in the design of the curriculum would be that the majority of workers' age falls between 30 and 40 years and that the average educational level was a high school diploma. Since 100% of the companies used on-the-job training as a strategy for bringing new or transferred employees to a desired job performance level, it would be recommended that all training curriculums be developed around practical experiences relevant to actual work performance in the Powdered Metals Industry.

A specific recommendation for design of curriculum related to SPC should be developed by using Powdered Metals customers and plant managers as an information resource to incorporate practicality into the training. Individual organizations should consider developing internal in depth needs assessment to address strategies for knowledges and skills needed for future growth.

APPENDIX A

Manager's Interview Questions

Does your organization work under union contracts? _____

Approximate number of current employees in organization? _____

Do you anticipate a change in this number within the next five years?

_____

If a change is expected will it go up or down and what percentage of the current workforce? _____

What percentage of your workforce is:

under 30 years of age? _____
between 30-40 years of age? _____
between 40-50 years of age? _____
over 50 years of age? _____

What percentage of your workers' education is:

less than high school diploma? _____
high school diploma? _____
more than high school diploma? _____

What percentage of your workers have vocational training? _____

Do you find any voids in the skill and knowledge level of your employees? _____ If so, what areas? _____

_____

What training strategies are utilized for existing positions? _____

_____

What training strategies are utilized for new technology? _____

What is the selection process for new positions? _____

_____

What is the role of human resource development in planning for new technology?

_____

_____

What demographics do you look for in new hires with respect to:

age? _____
education? _____
experience in related area? _____

How do you determine skill level of new employees:

testing? _____
interview? _____
both? _____

How do you train or advance employees from entry level to desired job level performance? _____

_____

How much time is expected for a new employee to reach desired job skill?

_____

Do you have a Quality Control Department? _____ If so, what kind?

_____

Do you subcontract work? _____

Who is responsible for the quality control of subcontracted work?

_____

What are the quality control standards of your major customers? _____

_____

Is the condition of your production machinery:

excellent? _____
good? _____
fair? _____
less than fair? _____

Who does the maintenance on your machinery? _____

What policy is used for machine maintenance:

interval? _____
repair only? _____

Do you implement any multi-craft training? _____

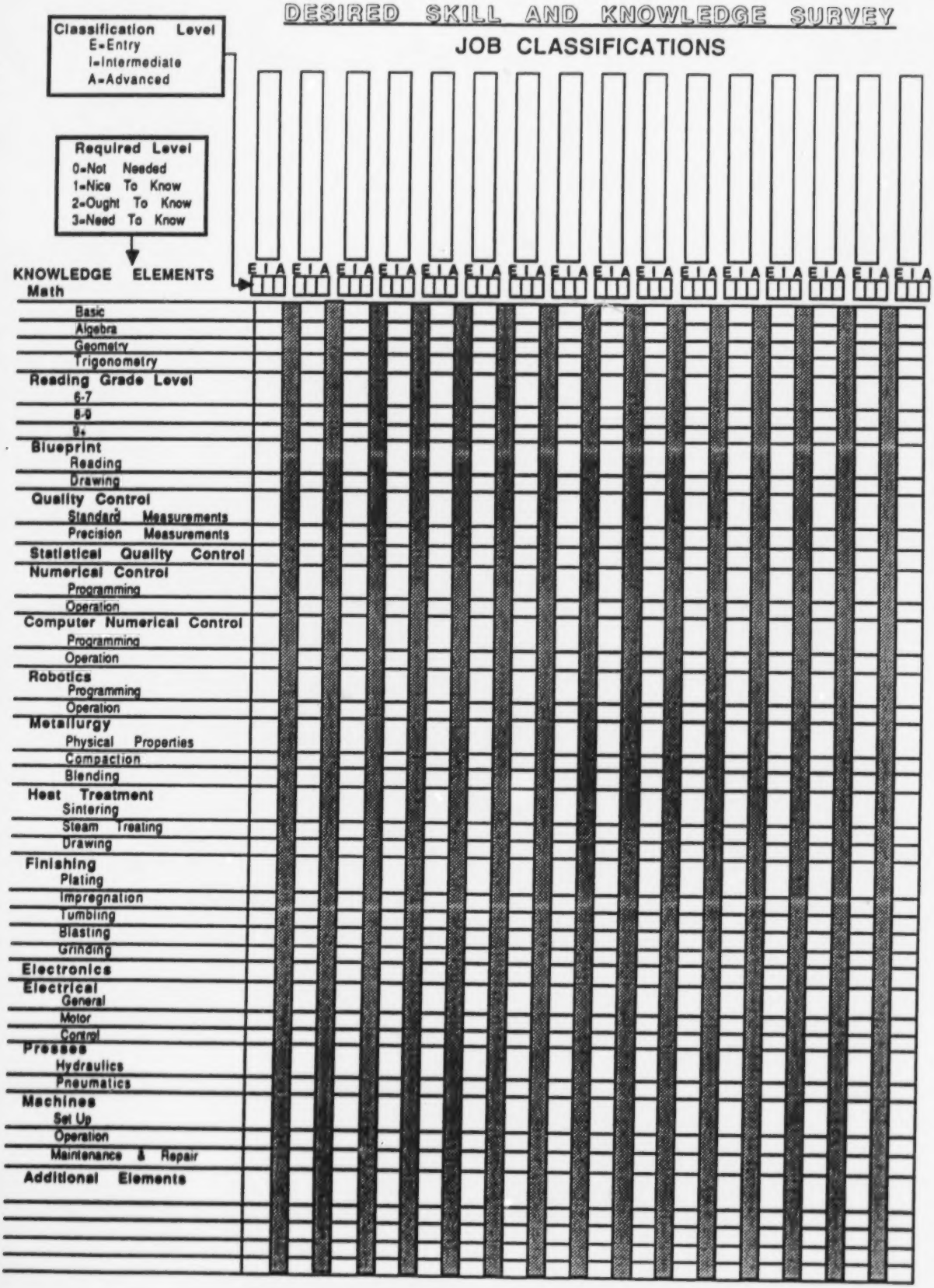
Do production employees perform various jobs or only one? _____

Do maintenance employees work where needed or specialize? _____

Can we interview a representative group of employees from your organization?

_____

DESIRED SKILL AND KNOWLEDGE SURVEY



EMPLOYEE SURVEY

DIRECTIONS :

1. Write in your current job classification in the space provided.
2. Listed below are knowledge elements, think about your job and how these knowledges relate to your work activity.
3. In the space provided to the right of each knowledge element circle either a 0, 1, 2, or 3 based on the following explanations.
   Circle a; 0 if the knowledge element is not needed for your job.
   1 if the knowledge element would be nice to know for performance or understanding of your job.
   2 if the knowledge element ought to be known for efficient performance of your job.
   3 if the knowledge element needs to be known to perform your job in any capacity.
4. To the far right of each knowledge element notice the words WEAK and STRONG, check only one based on what you feel best describes your ability level.

---

① JOB CLASSIFICATION: _____

②KNOWLEDGE ELEMENTS	③	④STRONG WEAK
Math		
Basic	0 1 2 3	
Algebra	0 1 2 3	
Geometry	0 1 2 3	
Trigonometry	0 1 2 3	
Reading Grade Level		
6-7	0 1 2 3	
8-9	0 1 2 3	
9+	0 1 2 3	
Blueprint		
Reading	0 1 2 3	
Drawing	0 1 2 3	
Quality Control		
Standard Measurements	0 1 2 3	
Precision Measurements	0 1 2 3	
Statistical Quality Control	0 1 2 3	
Numerical Control		
Programming	0 1 2 3	
Operation	0 1 2 3	
Computer Numerical Control		
Programming	0 1 2 3	
Operation	0 1 2 3	
Robotics		
Programming	0 1 2 3	
Operation	0 1 2 3	
Metallurgy		
Physical Properties	0 1 2 3	
Compaction	0 1 2 3	
Blending	0 1 2 3	
Heat Treatment		
Sintering	0 1 2 3	
Steam Treating	0 1 2 3	
Drawing	0 1 2 3	
Finishing		
Plating	0 1 2 3	
Impregnation	0 1 2 3	
Tumbling	0 1 2 3	
Blasting	0 1 2 3	
Grinding	0 1 2 3	
Electronics	0 1 2 3	
Electrical		
General	0 1 2 3	
Motor	0 1 2 3	
Control	0 1 2 3	
Presses		
Hydraulics	0 1 2 3	
Pneumatics	0 1 2 3	
Machines		
Set Up	0 1 2 3	
Operation	0 1 2 3	
Maintenance & Repair	0 1 2 3	

APPENDIX B

INDUSTRY WIDE
MANAGER DESIRED KNOWLEDGE DATA

One Way ANOVA 38 Groups

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	37	329.303	8.9	25.546
Wihin groups	608	211.827	.348	$p \leq .0001$
Total	645	541.131		

Model II estimate of between component variance = .503

Group:	Count:	Mean:
BASIC	17	2.796
ALGEBRA	17	1.214
GEOMETRY	17	.886
TRIGONOMETRY	17	.61
6-7	17	2.713

Group:	Count:	Mean:
8-9	17	2.62
9+	17	2.549
B.P. READING	17	2.168
B. P. DRAWING	17	.783
STANDARD MEAS.	17	2.152

Group:	Count:	Mean:
PRECISION MEAS.	17	1.866
SQC	17	1.763
N.C. PROGRAM	17	.509
N.C. OPER	17	.841
CNC PROGRAM	17	.354

Group:	Count:	Mean:
CNC OPER	17	.645
ROB PROGRAM	17	.4
ROB OPER	17	.664
PHYSICAL PROP	17	.954
COMPACTION	17	.973

Industry Wide
Manager Desired Knowledge Data

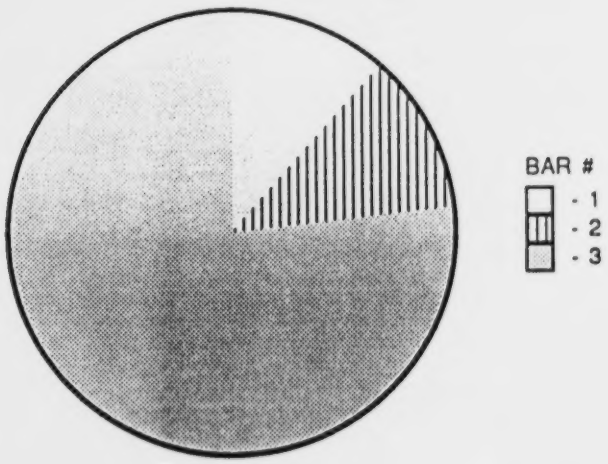
Group:	Count:	Mean:
BLENDING	17	.787
SINTERING	17	.965
STEAM TREAT	17	.517
HT DRAWING	17	.44
PLATING	17	.477

Group:	Count:	Mean:
IMPREGNATION	17	.656
TUMBLING	17	.731
BLASTING	17	.37
GRINDING	17	.55
ELECTRONICS	17	.442

Group:	Count:	Mean:
GENERAL	17	.882
MOTOR	17	.759
CONTROL	17	.755
HYDRAULICS	17	1.16
PNEUMATICS	17	1.086

Group:	Count:	Mean:
SET UP	17	1.427
OPERATION	17	1.884
MAINT&REPAIR	17	1.308

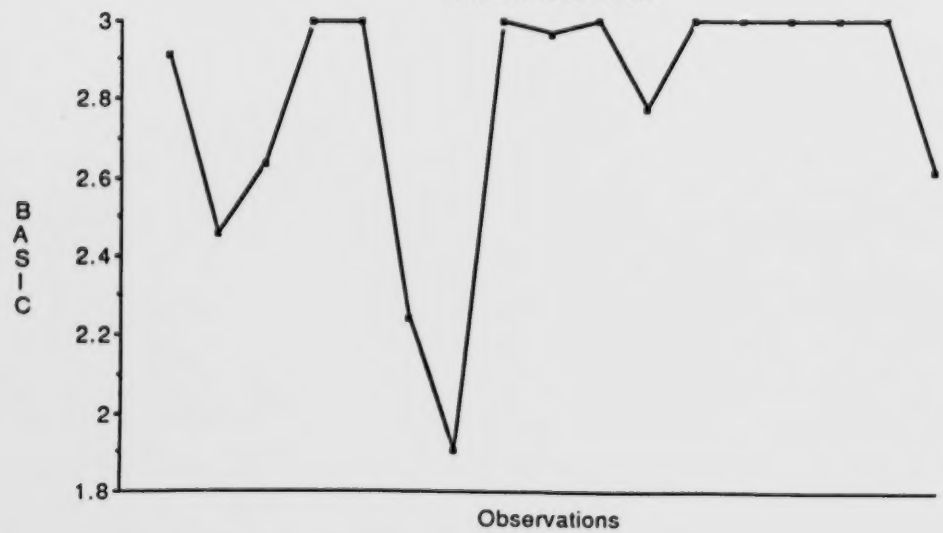
Pie Chart of BASIC



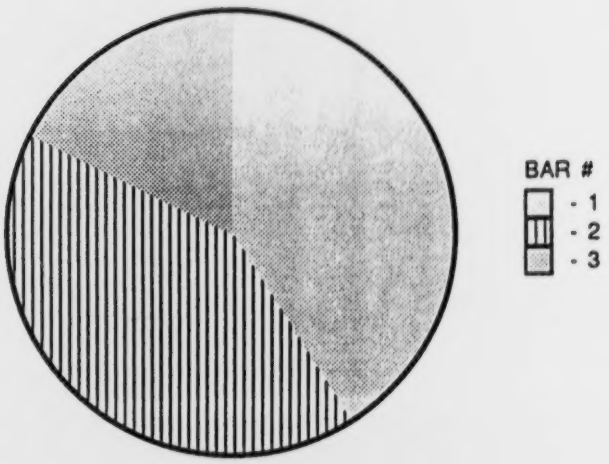
BASIC

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	1.905	2.27	2	11.765	
2	2.27	2.636	2	11.765	
3	2.636	3.001	13	76.471	-Mode

Line Chart of BASIC



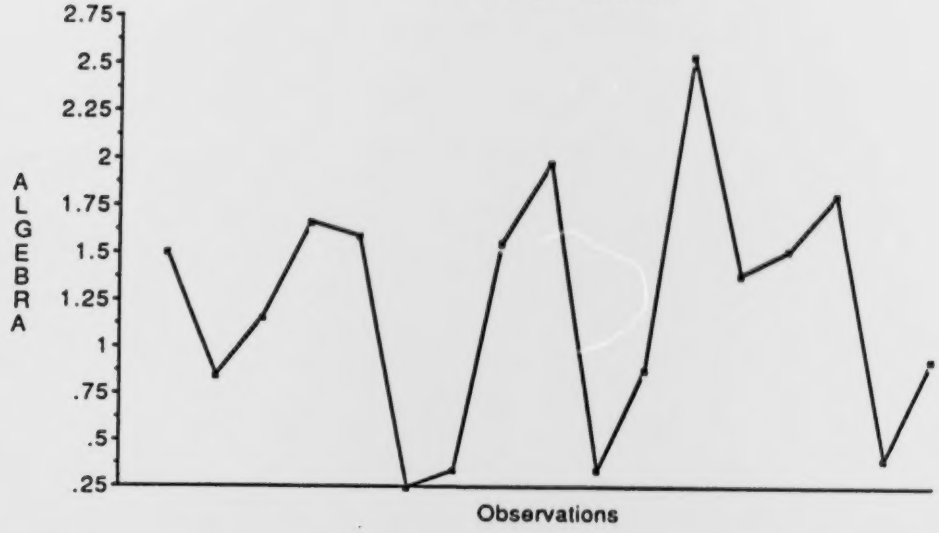
Pie Chart of ALGEBRA



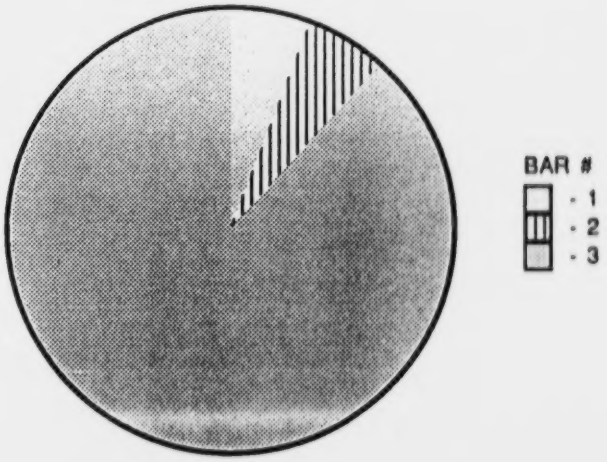
ALGEBRA

Bar:	From: (≥)	To: (<)	Count:	Percent:
1	.25	1.014	7	41.176
2	1.014	1.779	7	41.176
3	1.779	2.543	3	17.647

Line Chart of ALGEBRA



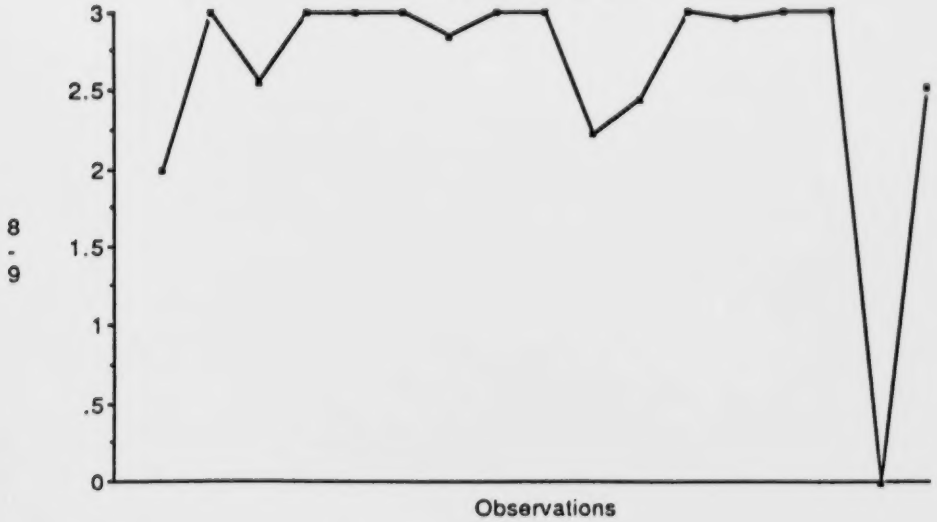
Pie Chart of 8-9



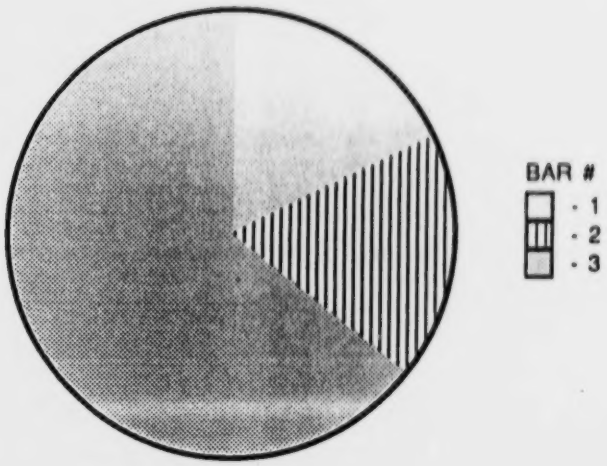
8-9

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	0	1	1	5.882	
2	1	2.001	1	5.882	
3	2.001	3.001	15	88.235	-Mode

Line Chart of 8-9



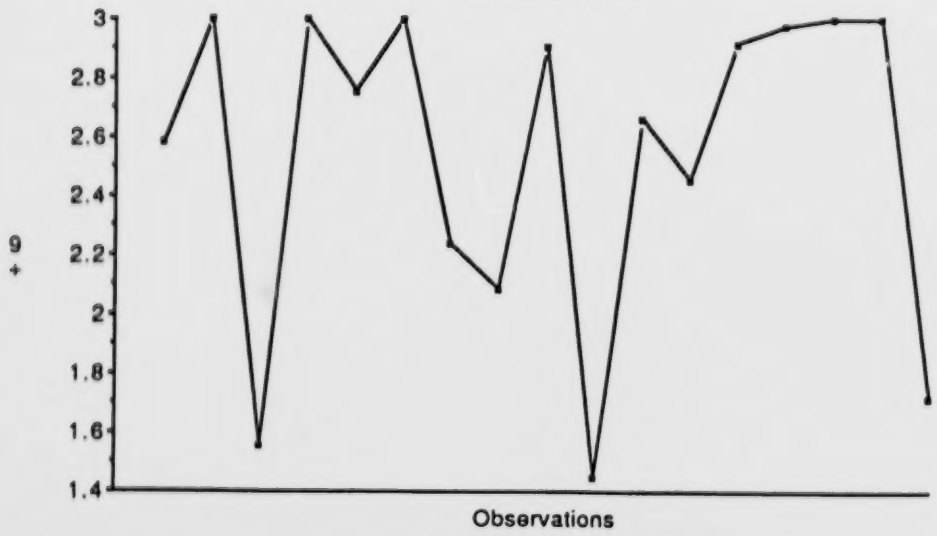
Pie Chart of 9+



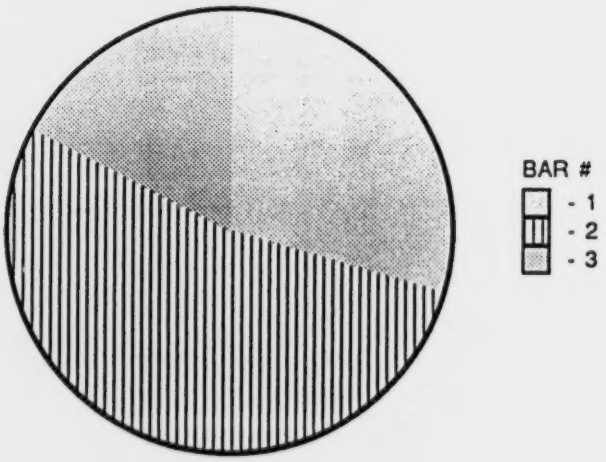
9+

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	1.444	1.963	3	17.647	
2	1.963	2.482	3	17.647	
3	2.482	3.001	11	64.706	-Mode

Line Chart of 9+



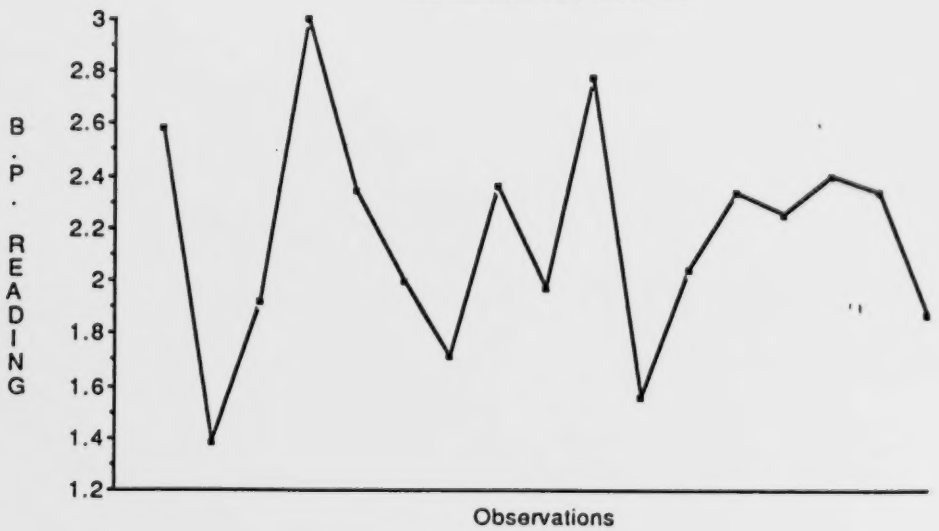
Pie Chart of B.P. READING



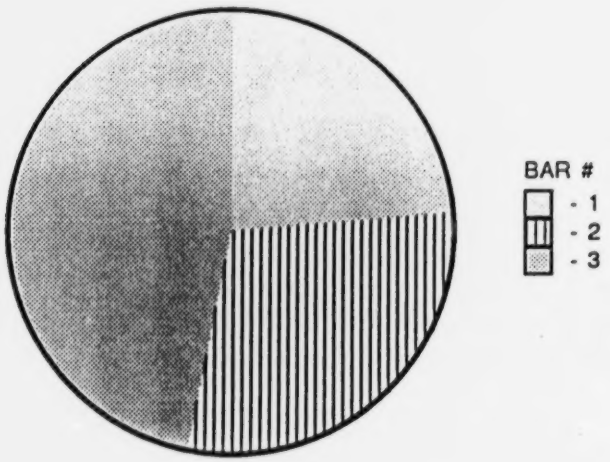
B.P. READING

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	1.385	1.924	5	29.412	
2	1.924	2.462	9	52.941	-Mode
3	2.462	3.001	3	17.647	

Line Chart of B.P. READING



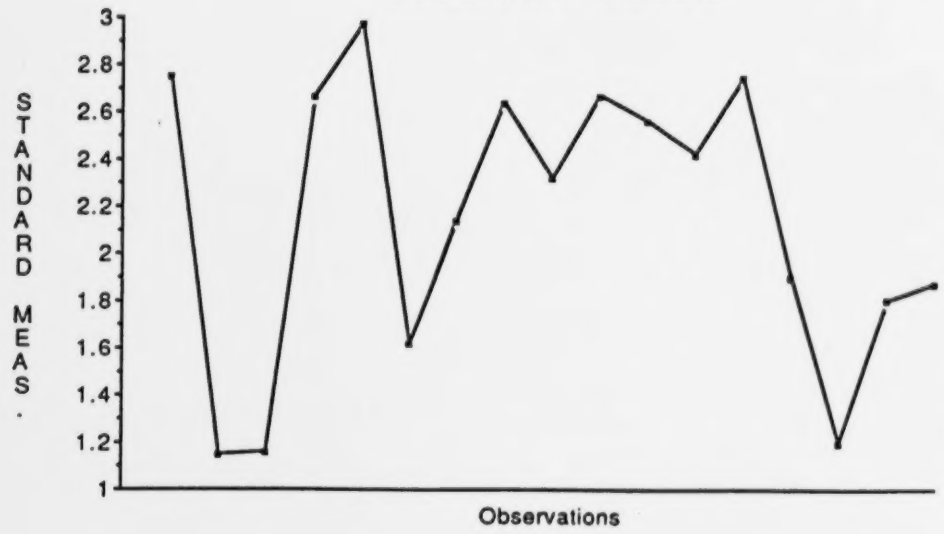
Pie Chart of STANDARD MEAS.



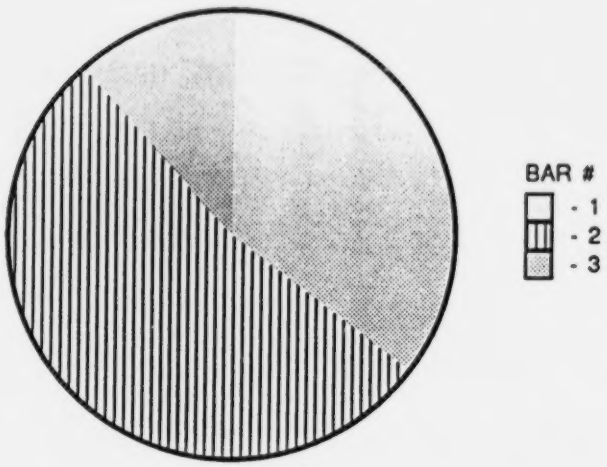
STANDARD MEAS.

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	1.154	1.758	4	23.529	
2	1.758	2.363	5	29.412	
3	2.363	2.967	8	47.059	-Mode

Line Chart of STANDARD MEAS.



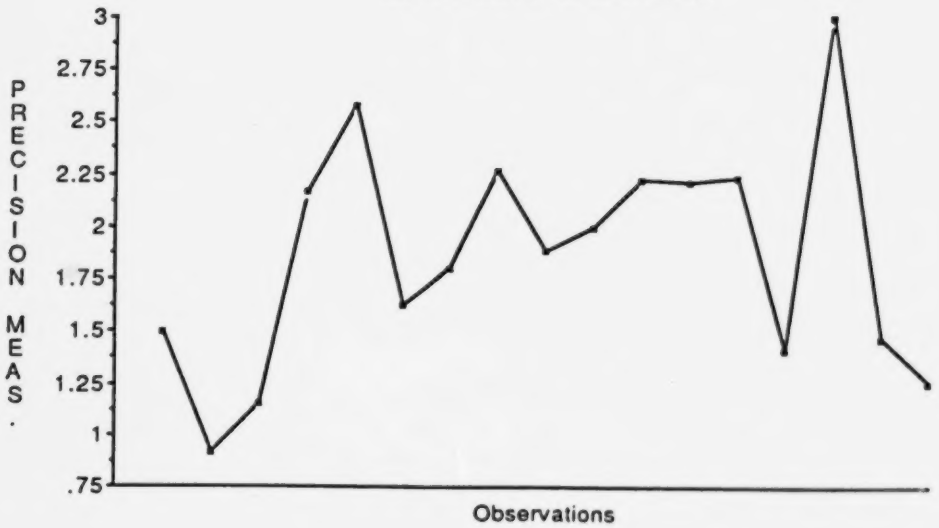
Pie Chart of PRECISION MEAS.



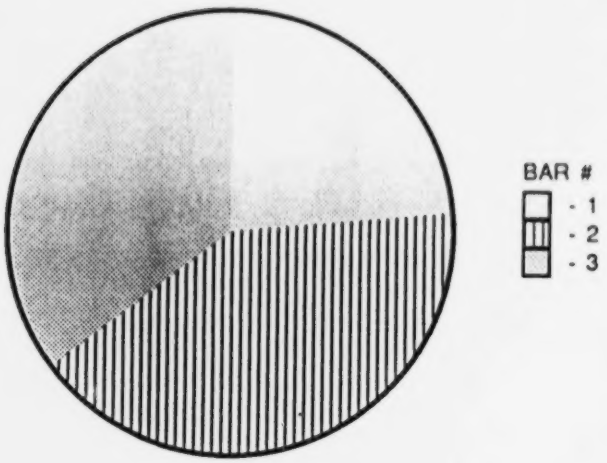
PRECISION MEAS.

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.923	1.616	6	35.294	
2	1.616	2.308	9	52.941	-Mode
3	2.308	3.001	2	11.765	

Line Chart of PRECISION MEAS.



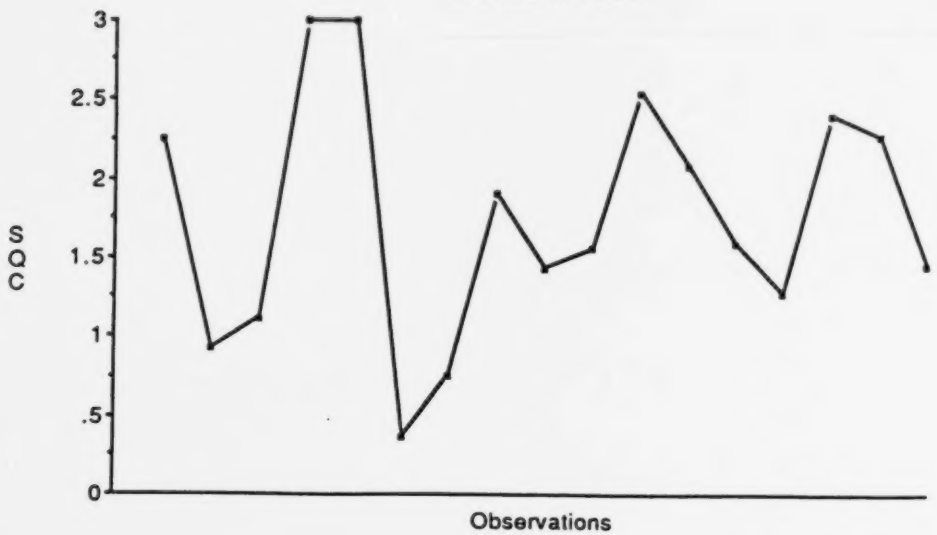
Pie Chart of SQC



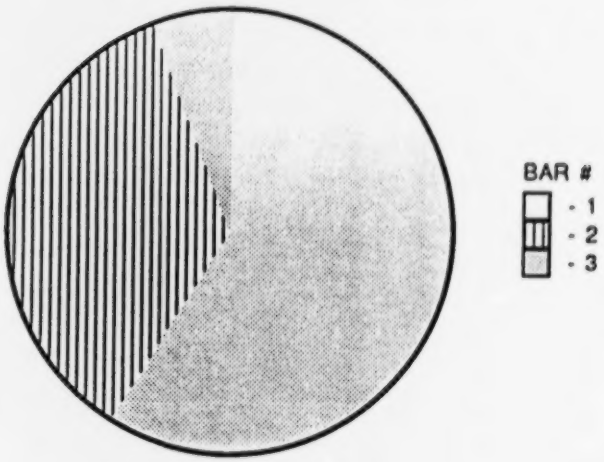
SQC

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.375	1.25	4	23.529	
2	1.25	2.126	7	41.176	-Mode
3	2.126	3.001	6	35.294	

Line Chart of SQC



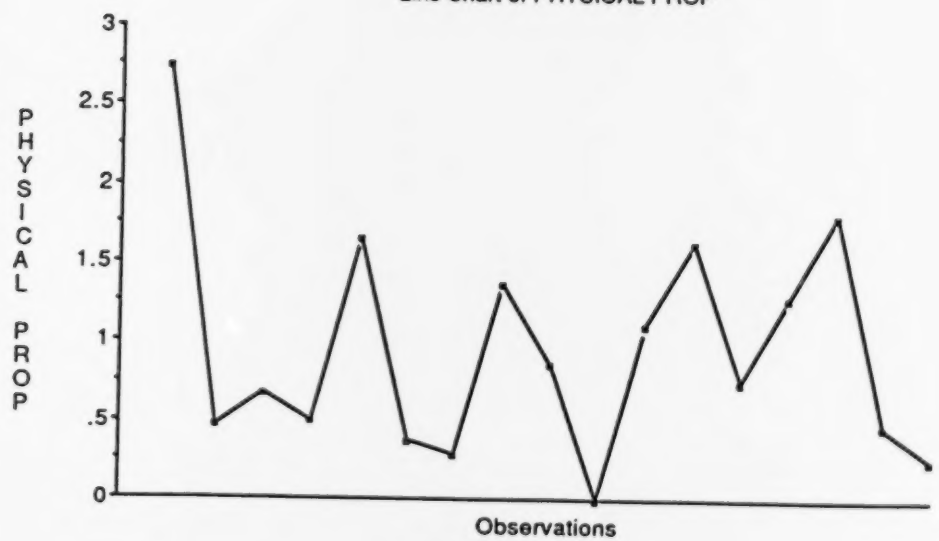
Pie Chart of PHYSICAL PROP



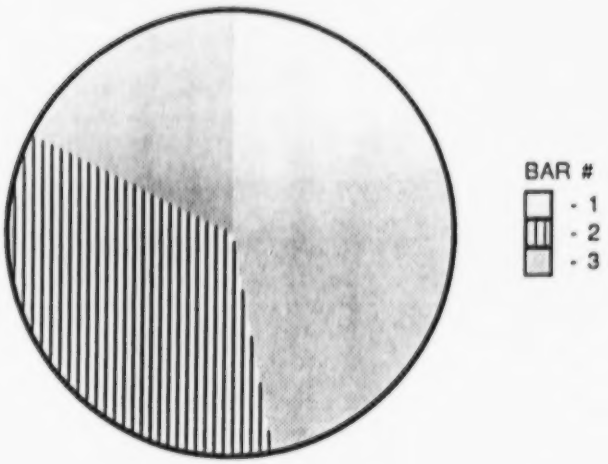
PHYSICAL PROP

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	0	.917	10	58.824	-Mode
2	.917	1.834	6	35.294	
3	1.834	2.751	1	5.882	

Line Chart of PHYSICAL PROP



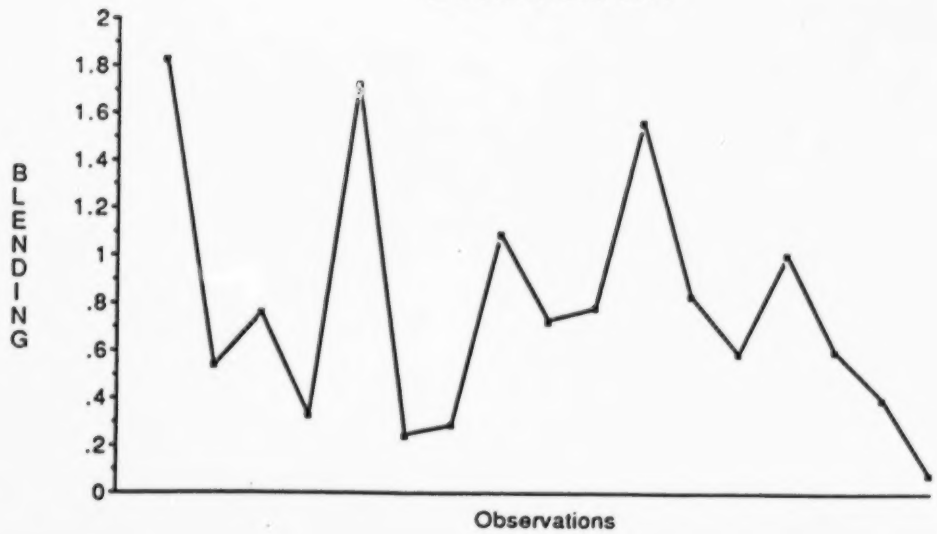
Pie Chart of BLENDING



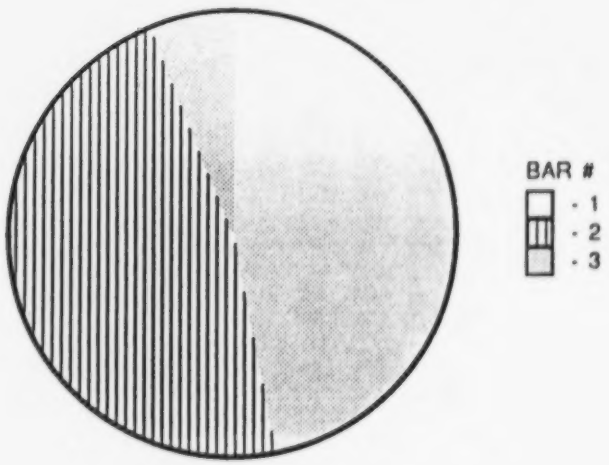
BLENDING

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.077	.663	8	47.059	-Mode
2	.663	1.248	6	35.294	
3	1.248	1.834	3	17.647	

Line Chart of BLENDING



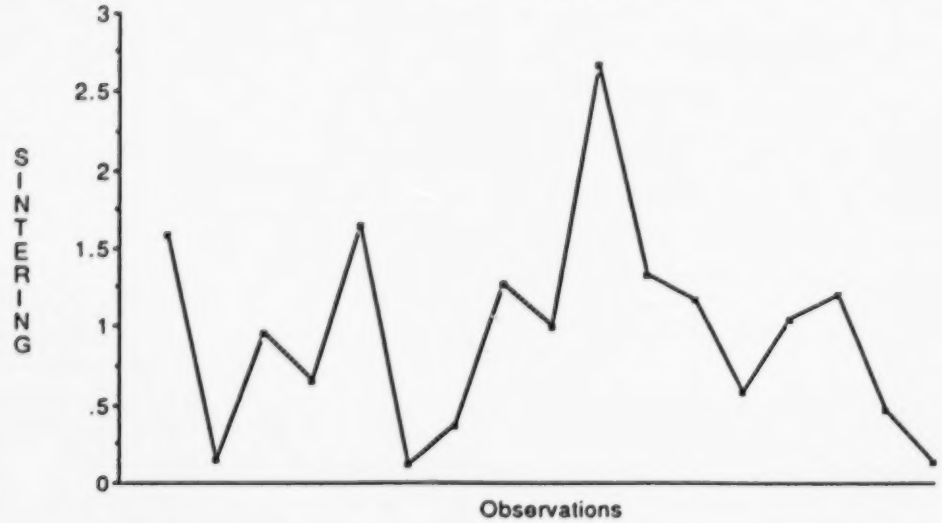
Pie Chart of SINTERING



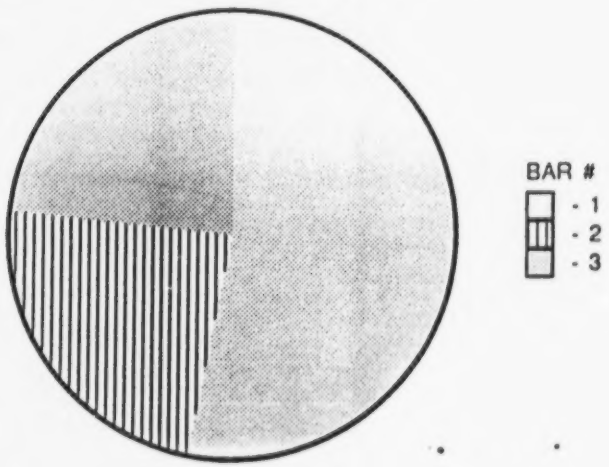
SINTERING

Bar:	From: (≥)	To: (<)	Count:	Percent:
1	.125	.973	8	47.059
2	.973	1.82	8	47.059
3	1.82	2.668	1	5.882

Line Chart of SINTERING



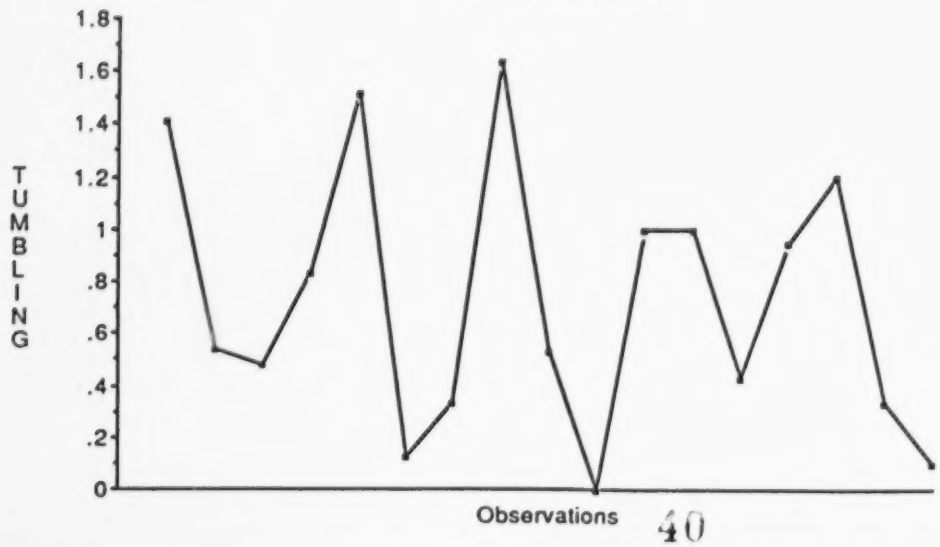
Pie Chart of TUMBLING



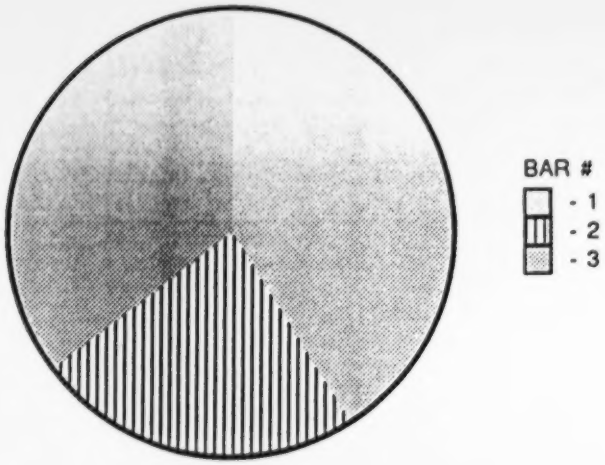
TUMBLING

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	0	.546	9	52.941	-Mode
2	.546	1.091	4	23.529	
3	1.091	1.637	4	23.529	

Line Chart of TUMBLING



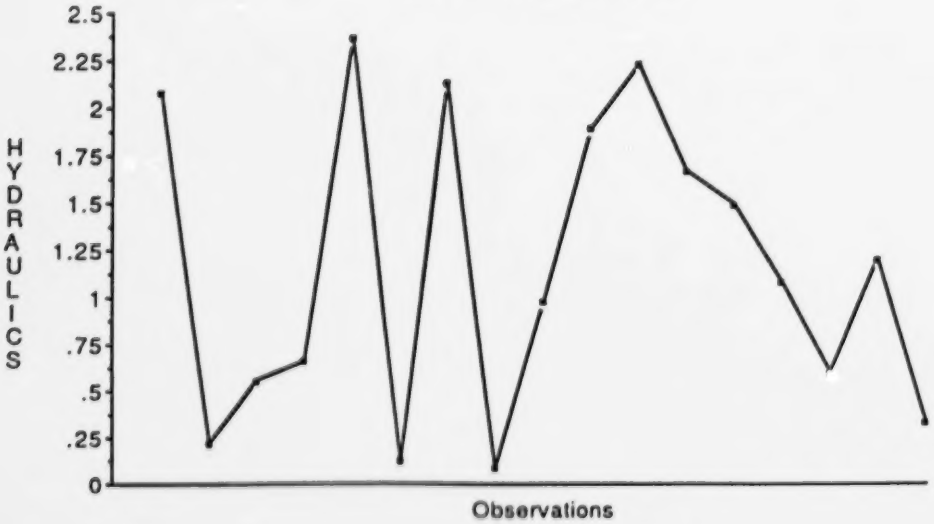
Pie Chart of HYDRAULICS



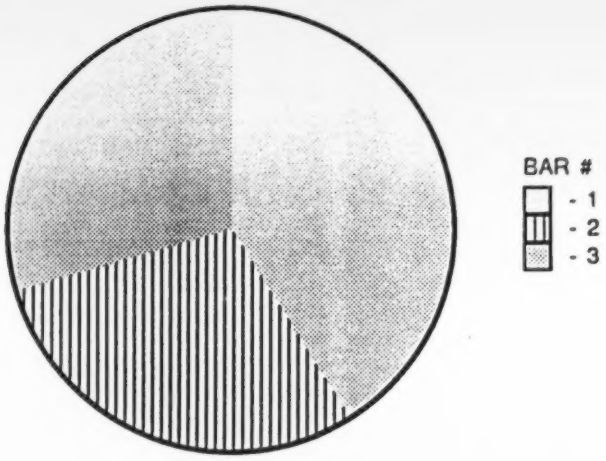
HYDRAULICS

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.091	.854	7	41.176	-Mode
2	.854	1.617	4	23.529	
3	1.617	2.38	6	35.294	

Line Chart of HYDRAULICS



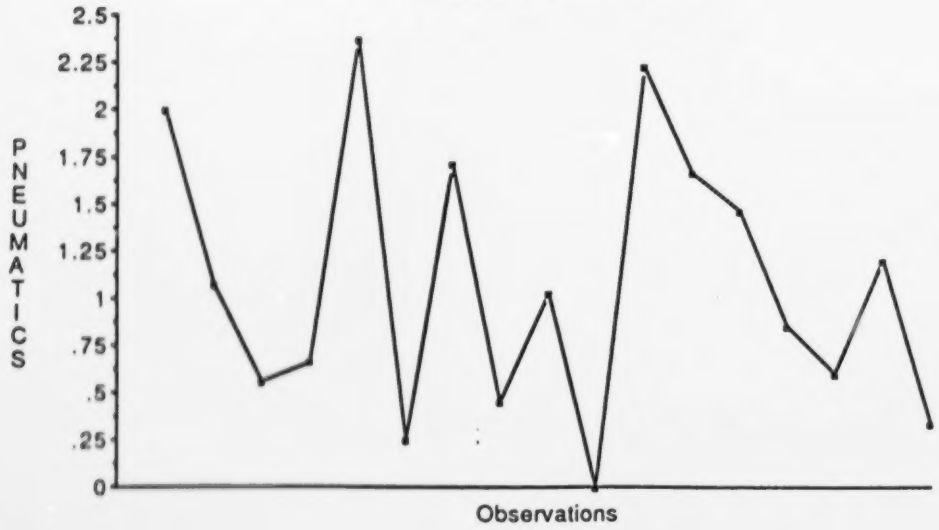
Pie Chart of PNEUMATICS



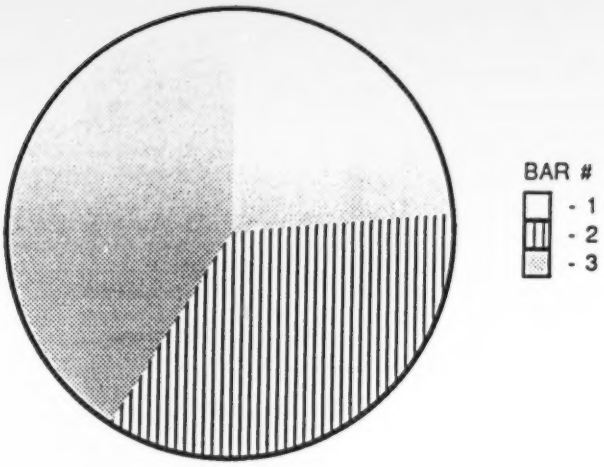
PNEUMATICS

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	0	.793	7	41.176	-Mode
2	.793	1.587	5	29.412	
3	1.587	2.38	5	29.412	

Line Chart of PNEUMATICS



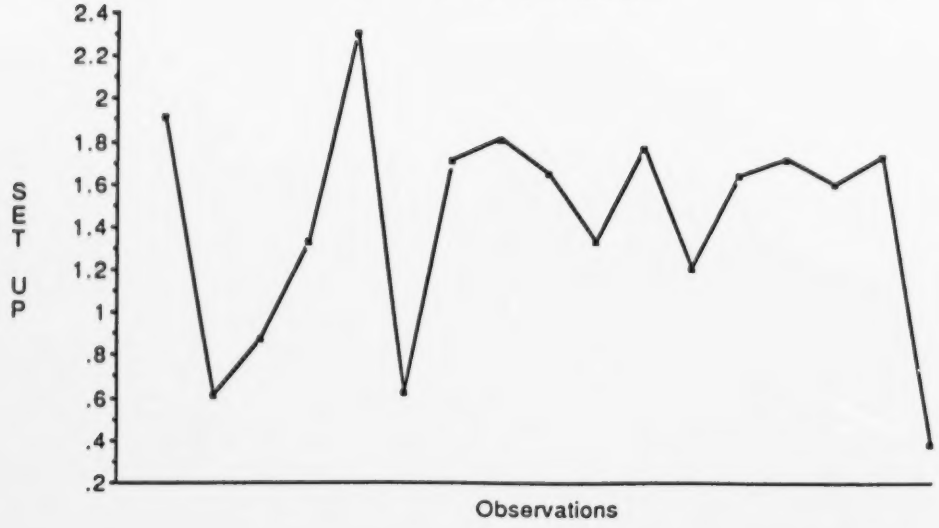
Pie Chart of SET UP



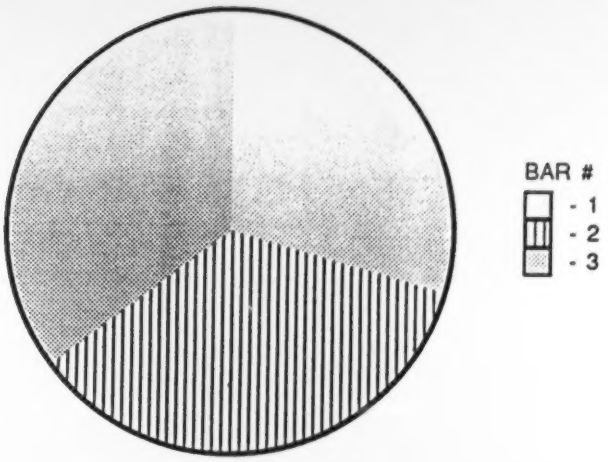
SET UP

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.385	1.027	4	23.529	
2	1.027	1.669	6	35.294	
3	1.669	2.311	7	41.176	-Mode

Line Chart of SET UP



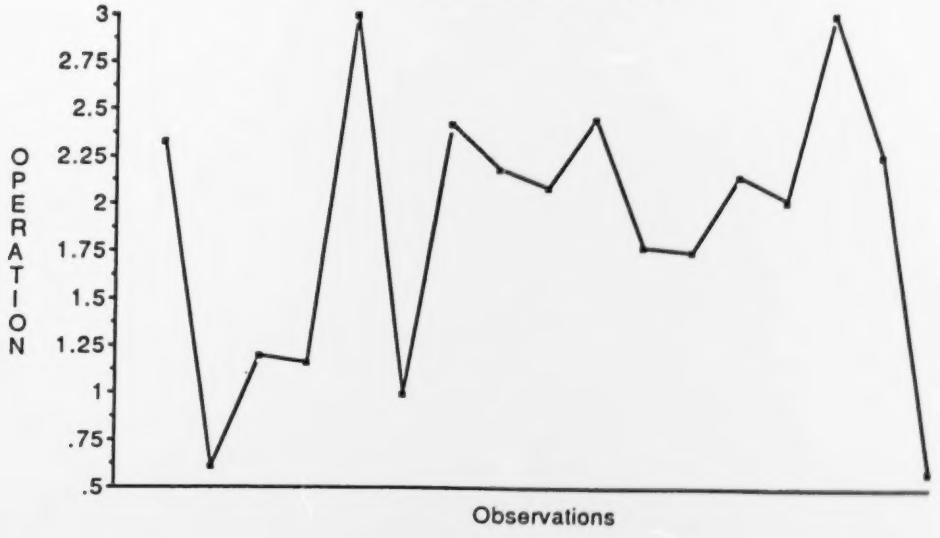
Pie Chart of OPERATION



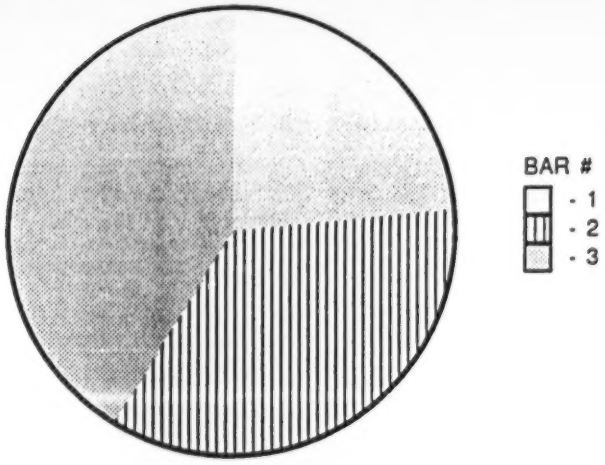
OPERATION

Bar:	From: (≥)	To: (<)	Count:	Percent:
1	.59	1.394	5	29.412
2	1.394	2.197	6	35.294
3	2.197	3.001	6	35.294

Line Chart of OPERATION



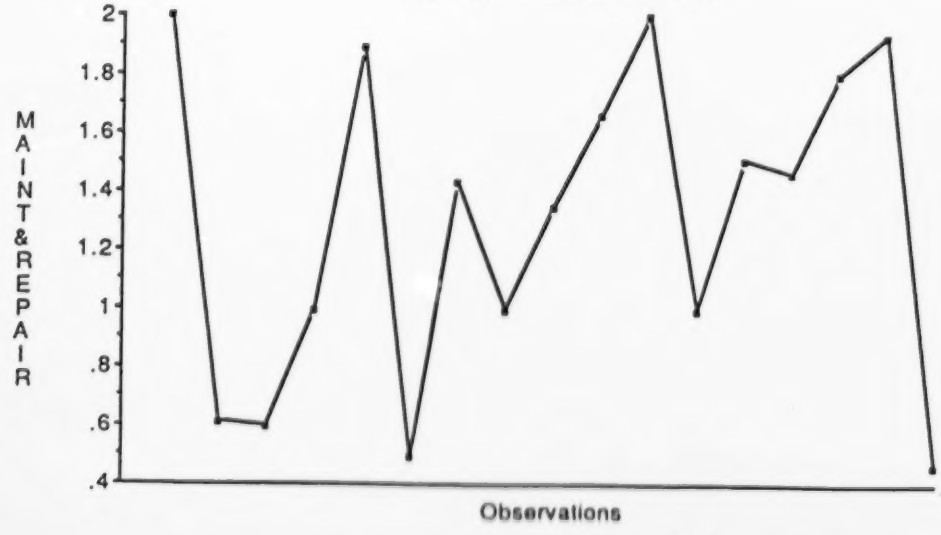
Pie Chart of MAINT&REPAIR



MAINT&REPAIR

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.462	.975	4	23.529	
2	.975	1.488	6	35.294	
3	1.488	2.001	7	41.176	-Mode

Line Chart of MAINT&REPAIR



APPENDIX C

INDUSTRY WIDE
EMPLOYEE PERCEIVED KNOWLEDGE DATA

One Way ANOVA 38 Groups

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
Between groups	37	152.22	4.114	16.898
Wihin groups	228	55.509	.243	$p \leq .0001$
Total	265	207.729		

Model II estimate of between component variance = .553

Group:	Count:	Mean:
BASIC	7	2.671
ALGEBRA	7	1.072
GEOMETRY	7	.938
TRIGONOMETRY	7	.622
6-7	7	2.849

Group:	Count:	Mean:
8-9	7	2.784
9+	7	2.741
B.P. READING	7	2.024
B. P. DRAWING	7	.926
STANDARD MEAS.	7	2.362

Group:	Count:	Mean:
PRECISION MEAS.	7	2.003
SQC	7	1.547
N.C. PROGRAM	7	.582
N.C. OPER	7	.627
CNC PROGRAM	7	.383

Group:	Count:	Mean:
CNC OPER	7	.435
ROB PROGRAM	7	.328
ROB OPER	7	.357
PHYSICAL PROP	7	1.029
COMPACTION	7	.996

Industry Wide
Employee Perceived Knowledge Data

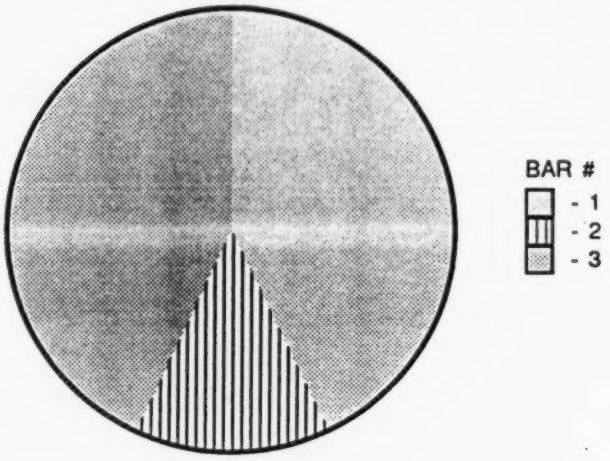
Group:	Count:	Mean:
BLENDING	7	1.12
SINTERING	7	1.253
STEAM TREAT	7	.571
HT DRAWING	7	.737
PLATING	7	.587

Group:	Count:	Mean:
IMPREGNATION	7	.987
TUMBLING	7	1.217
BLASTING	7	.344
GRINDING	7	.48
ELECTRONICS	7	.407

Group:	Count:	Mean:
GENERAL	7	.939
MOTOR	7	.705
CONTROL	7	.704
HYDRAULICS	7	.981
PNEUMATICS	7	.898

Group:	Count:	Mean:
SET UP	7	1.597
OPERATION	7	2.327
MAINT&REPAIR	7	1.598

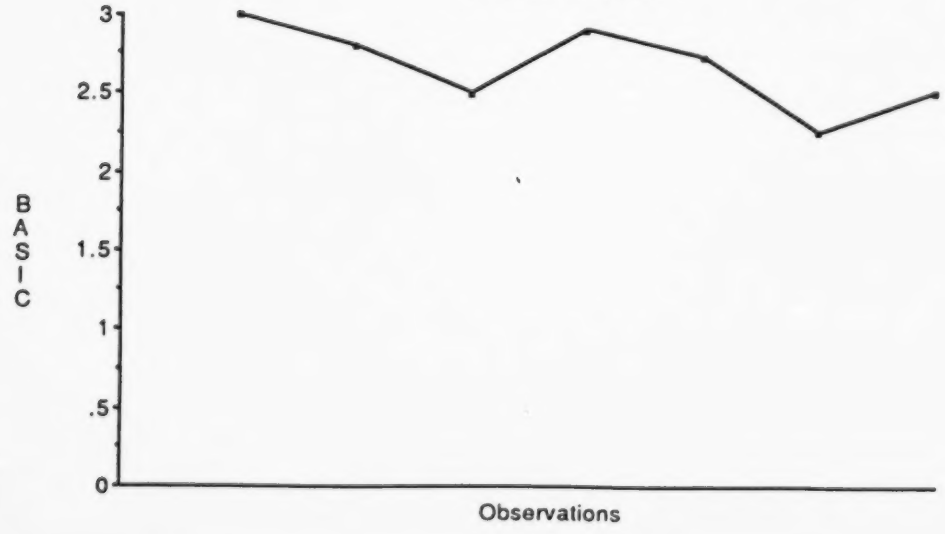
Pie Chart of BASIC



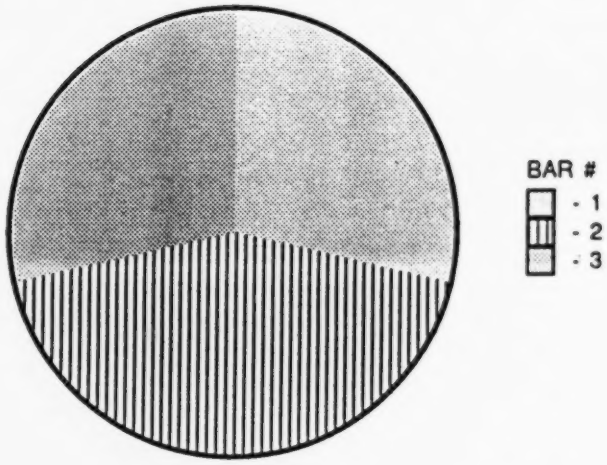
BASIC

Bar:	From: (≥)	To: (<)	Count:	Percent:
1	2.25	2.5	3	42.857
2	2.5	2.751	1	14.286
3	2.751	3.001	3	42.857

Line Chart of BASIC



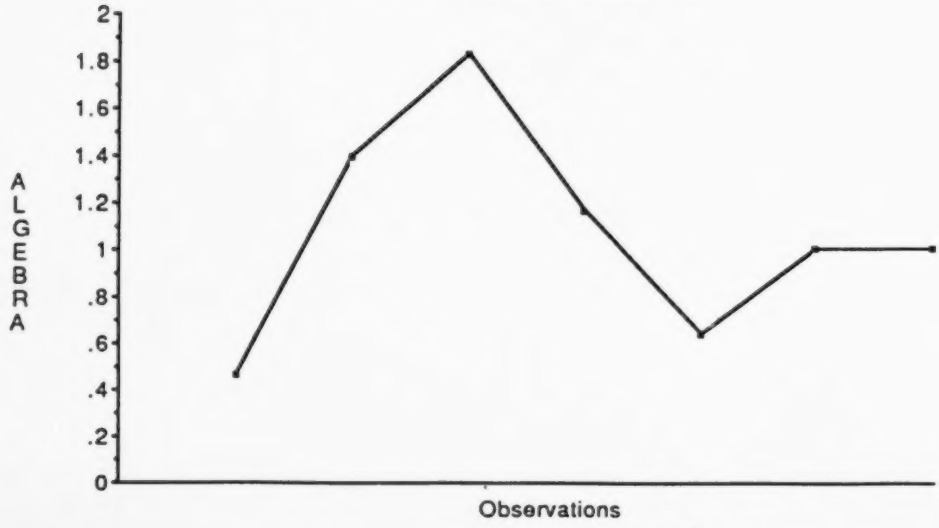
Pie Chart of ALGEBRA



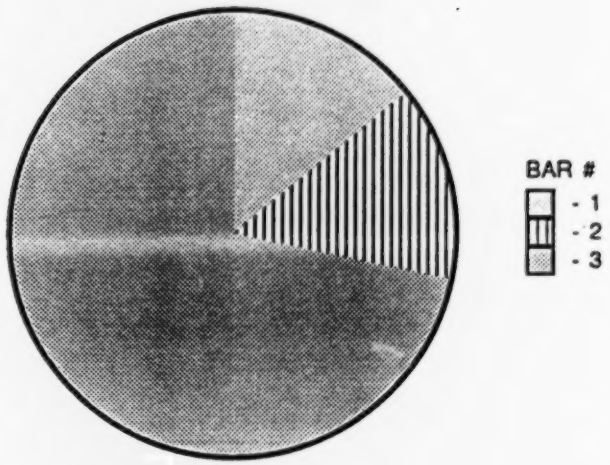
ALGEBRA

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.471	.925	2	28.571	
2	.925	1.38	3	42.857	-Mode
3	1.38	1.834	2	28.571	

Line Chart of ALGEBRA



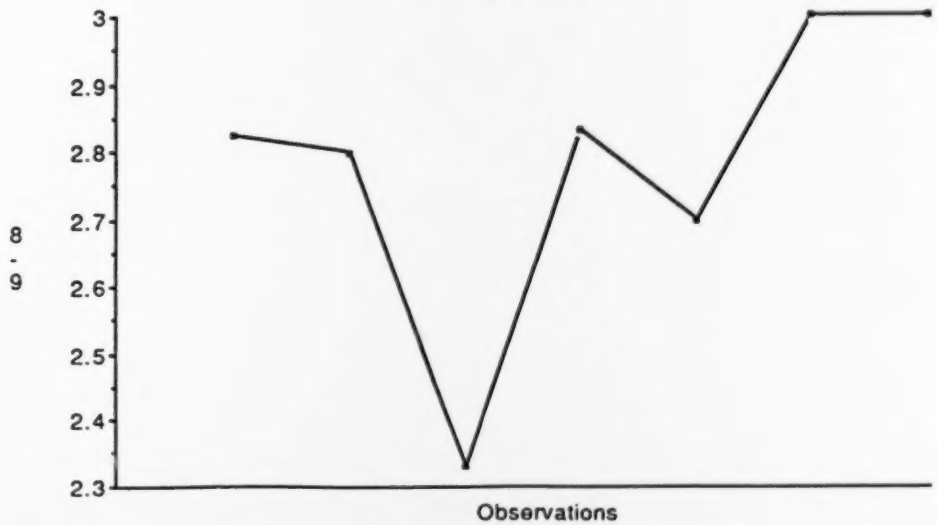
Pie Chart of 8-9



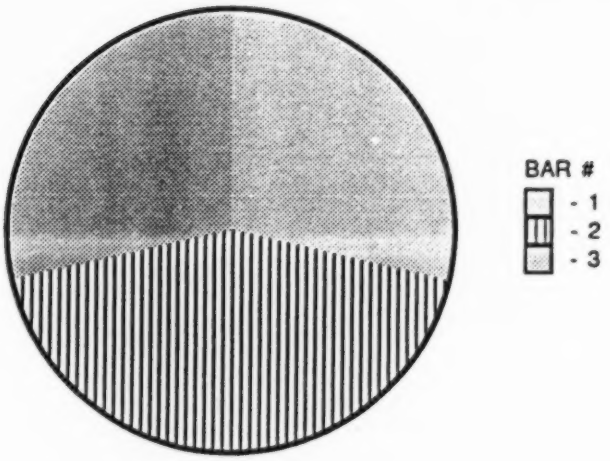
8-9

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	2.333	2.556	1	14.286	
2	2.556	2.778	1	14.286	
3	2.778	3.001	5	71.429	-Mode

Line Chart of 8-9



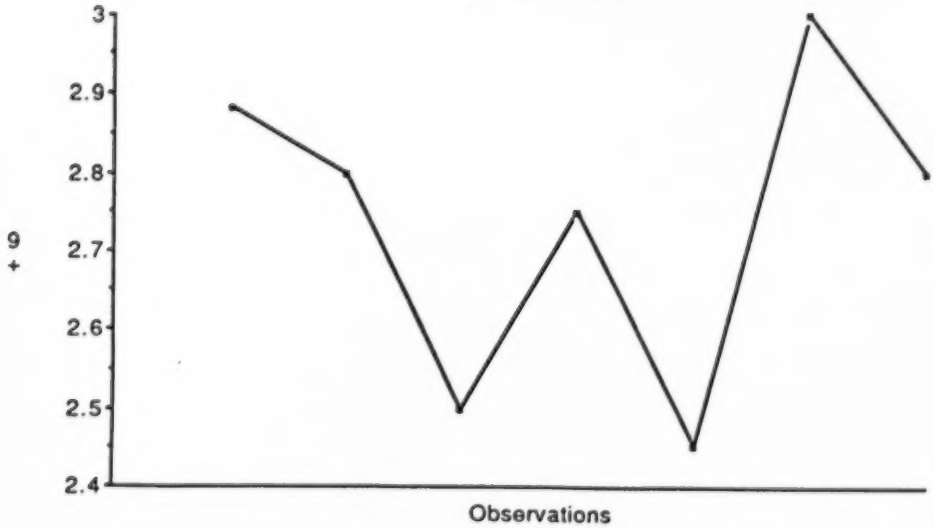
Pie Chart of 9+



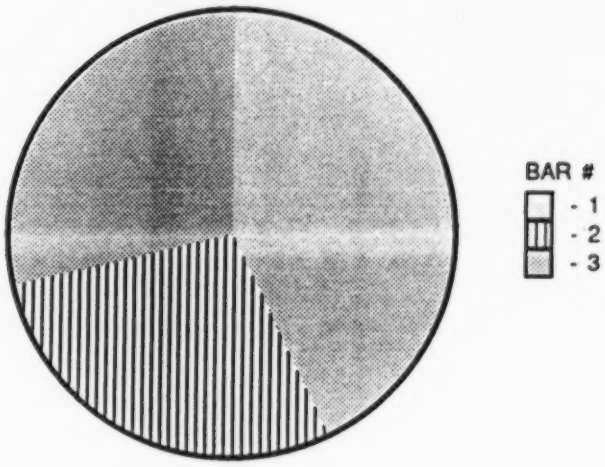
9+

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	2.455	2.637	2	28.571	
2	2.637	2.819	3	42.857	-Mode
3	2.819	3.001	2	28.571	

Line Chart of 9+



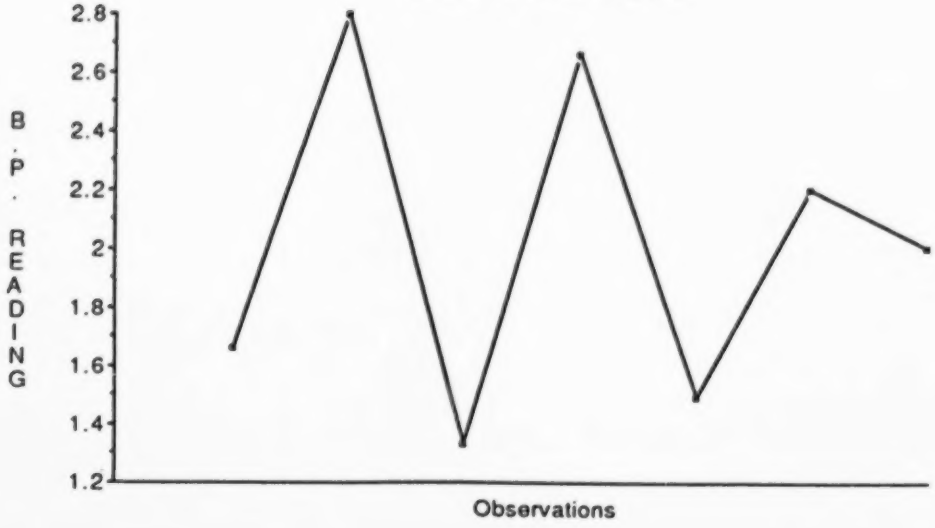
Pie Chart of B.P. READING



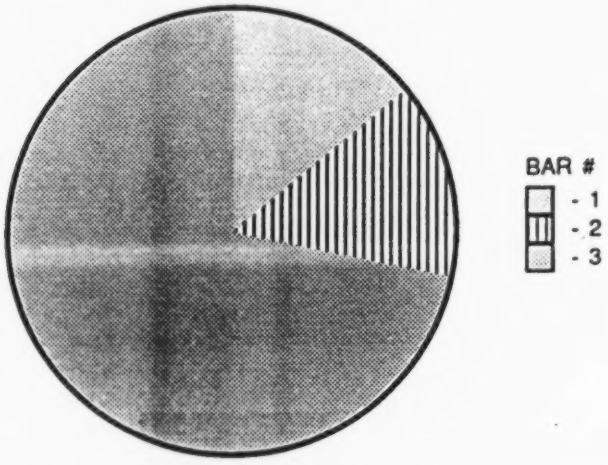
B.P. READING

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	1.333	1.822	3	42.857	-Mode
2	1.822	2.312	2	28.571	
3	2.312	2.801	2	28.571	

Line Chart of B.P. READING



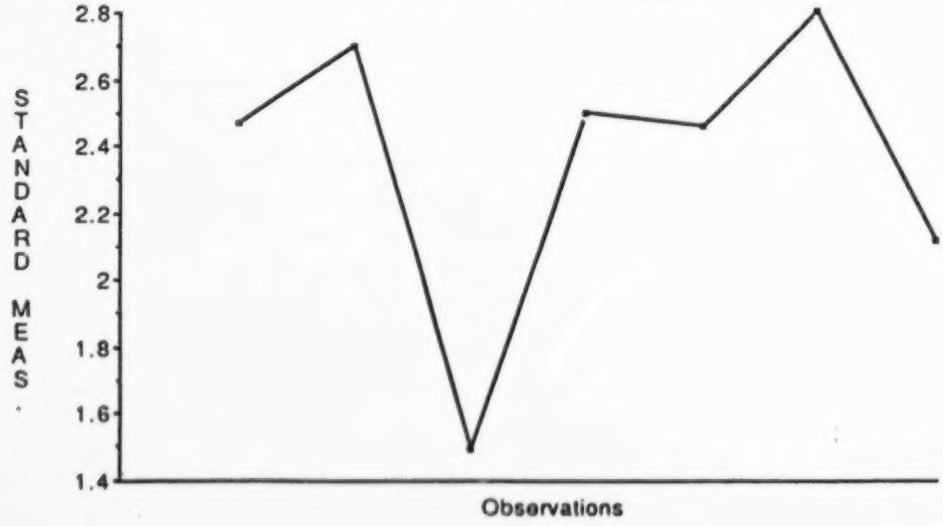
Pie Chart of STANDARD MEAS.



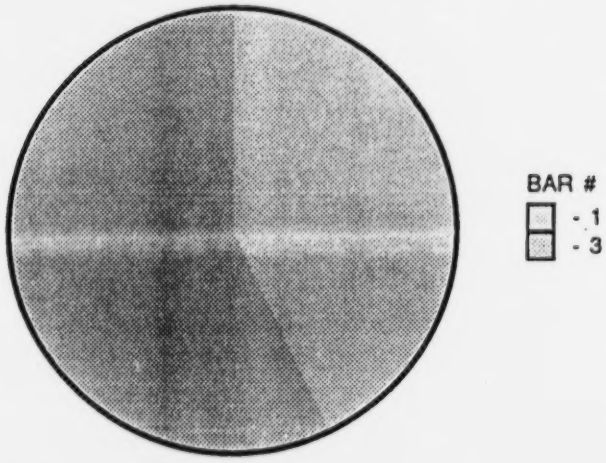
STANDARD MEAS.

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	1.5	1.934	1	14.286	
2	1.934	2.367	1	14.286	
3	2.367	2.801	5	71.429	-Mode

Line Chart of STANDARD MEAS.



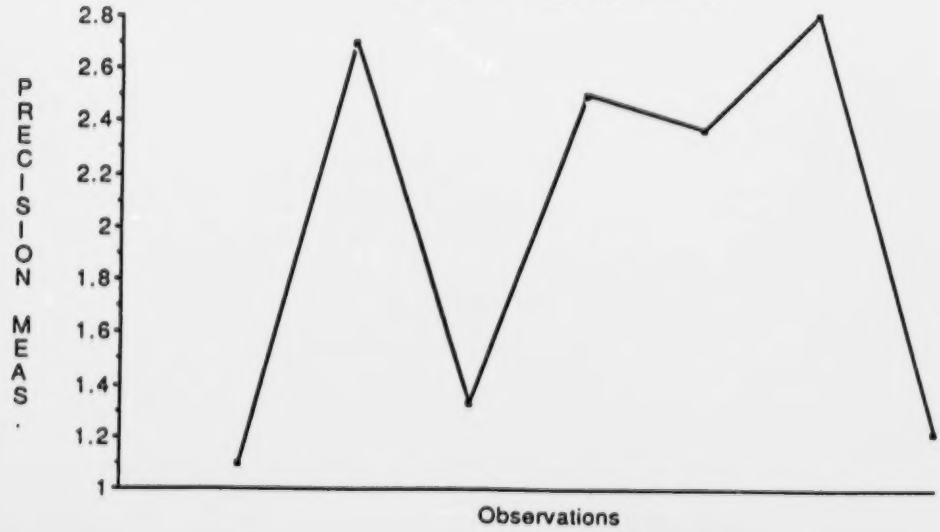
Pie Chart of PRECISION MEAS.



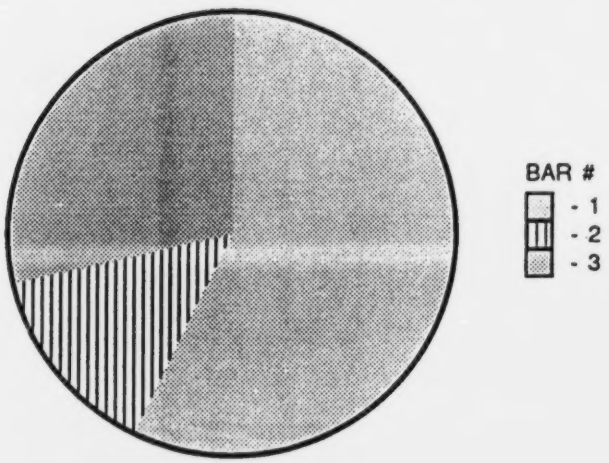
PRECISION MEAS.

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	1.1	1.667	3	42.857	
2	1.667	2.234	0	0	
3	2.234	2.801	4	57.143	-Mode

Line Chart of PRECISION MEAS.



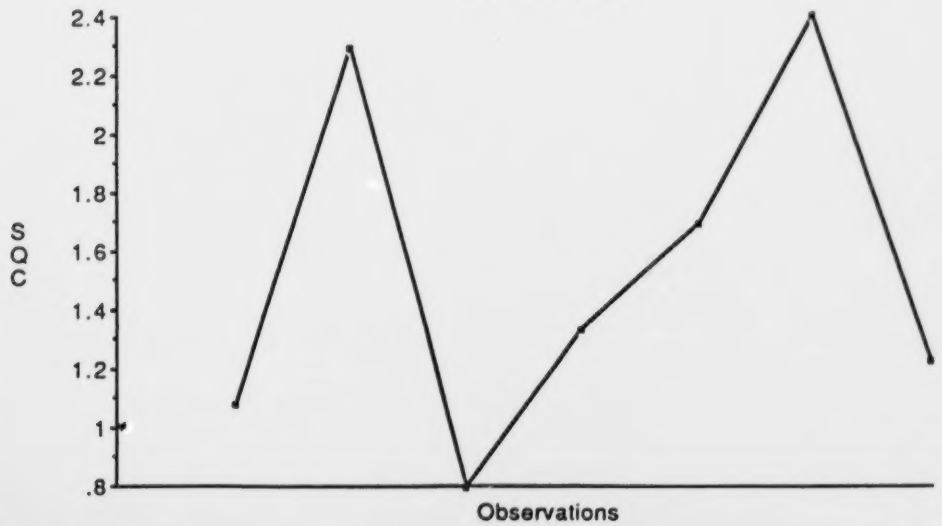
Pie Chart of SQC



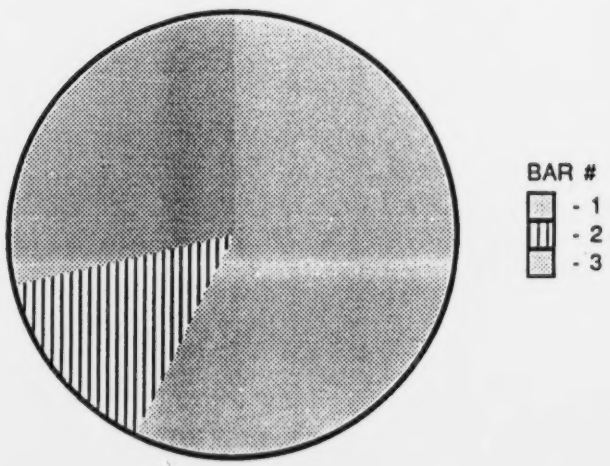
SQC

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.8	1.334	4	57.143	-Mode
2	1.334	1.867	1	14.286	
3	1.867	2.401	2	28.571	

Line Chart of SQC



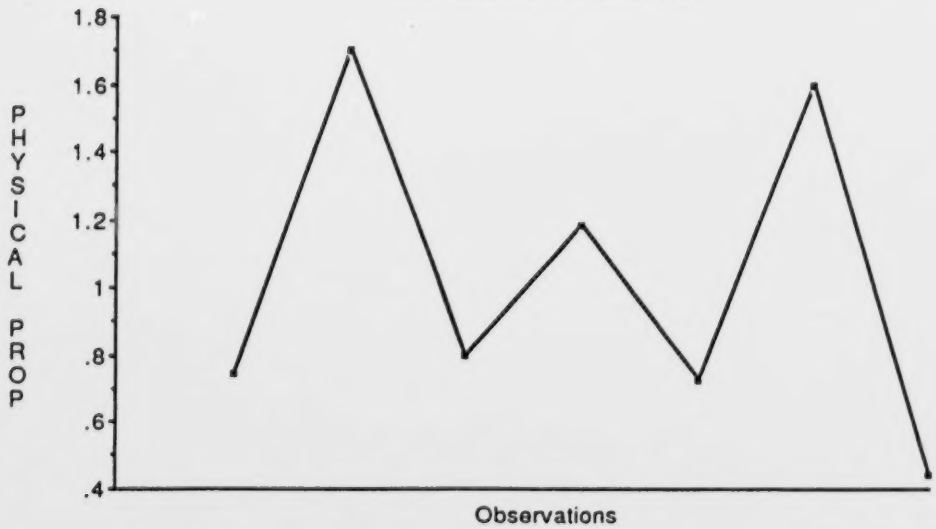
Pie Chart of PHYSICAL PROP



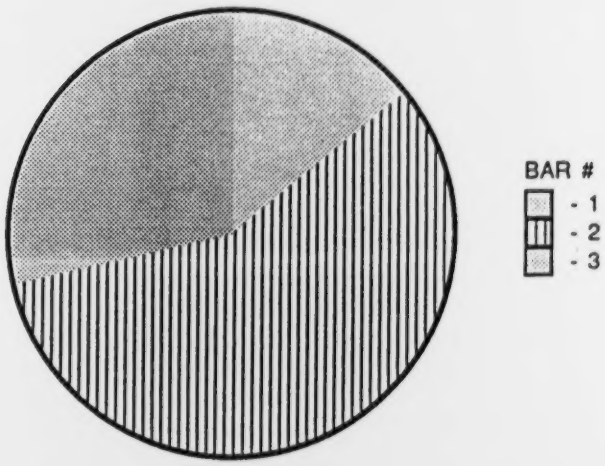
PHYSICAL PROP

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.444	.863	4	57.143	-Mode
2	.863	1.282	1	14.286	
3	1.282	1.701	2	28.571	

Line Chart of PHYSICAL PROP



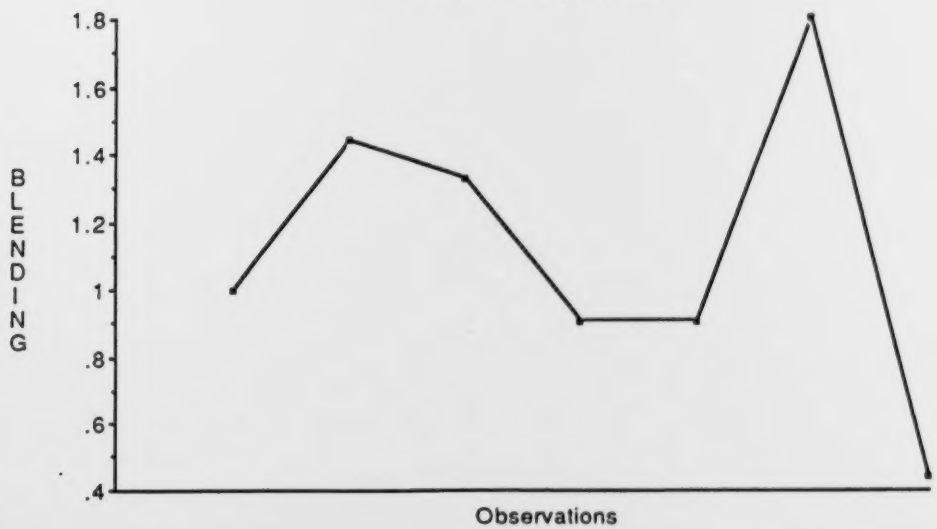
Pie Chart of BLENDING



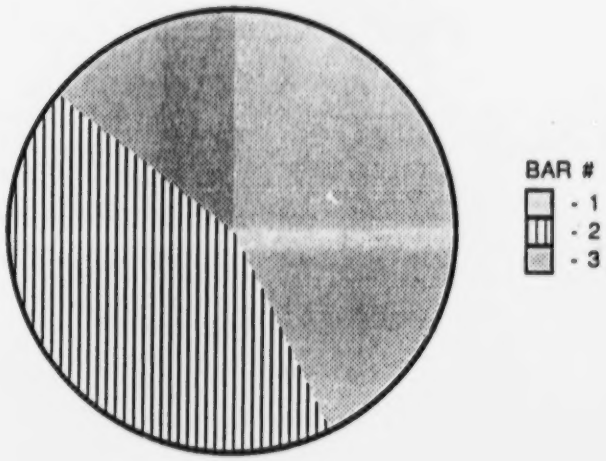
BLENDING

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.444	.896	1	14.286	
2	.896	1.349	4	57.143	-Mode
3	1.349	1.801	2	28.571	

Line Chart of BLENDING



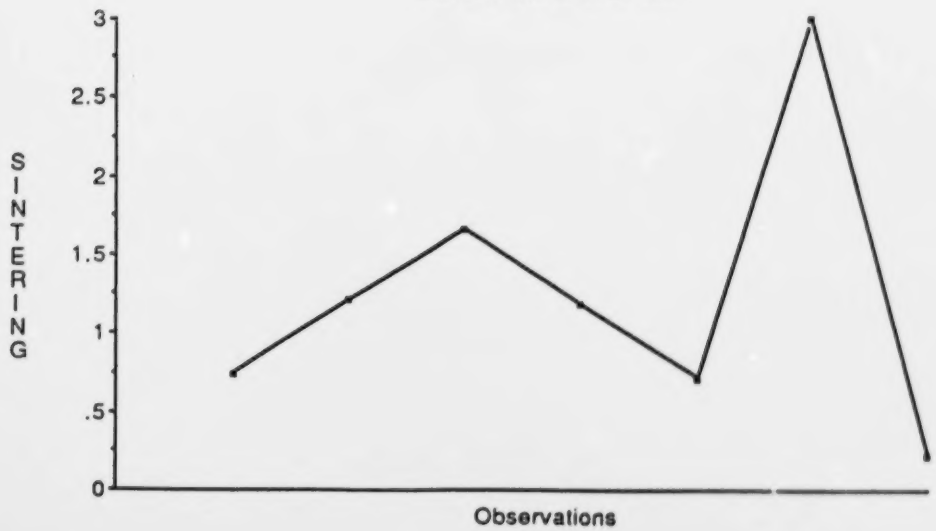
Pie Chart of SINTERING



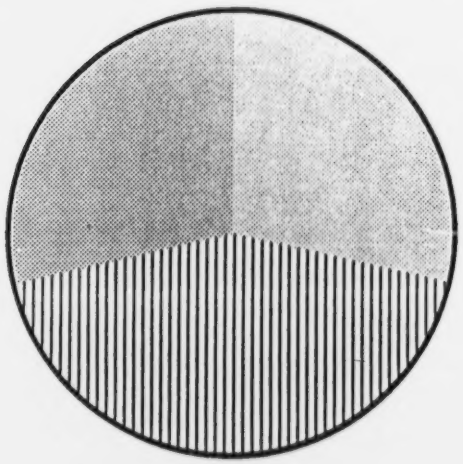
SINTERING

Bar:	From: (≥)	To: (<)	Count:	Percent:
1	.222	1.148	3	42.857
2	1.148	2.075	3	42.857
3	2.075	3.001	1	14.286

Line Chart of SINTERING



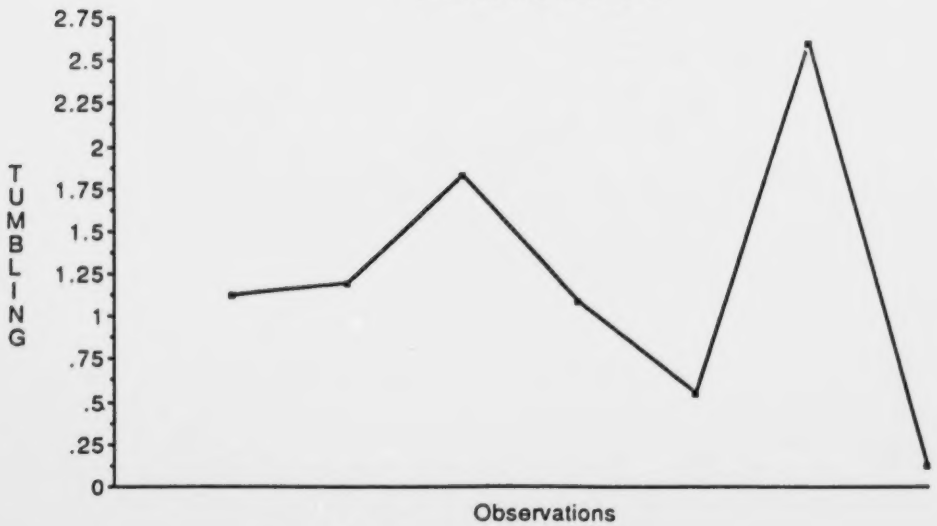
Pie Chart of TUMBLING



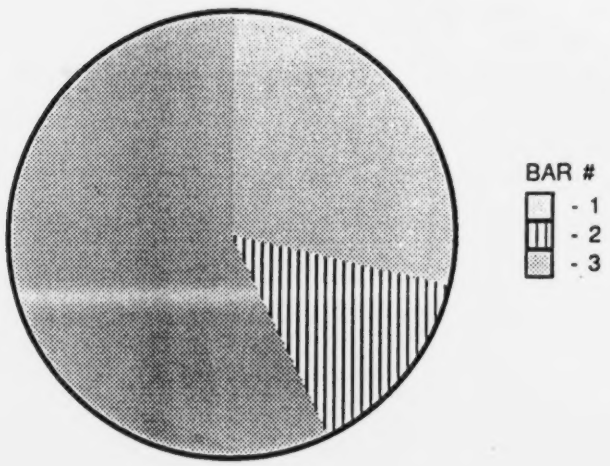
TUMBLING

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.125	.95	2	28.571	
2	.95	1.776	3	42.857	-Mode
3	1.776	2.601	2	28.571	

Line Chart of TUMBLING



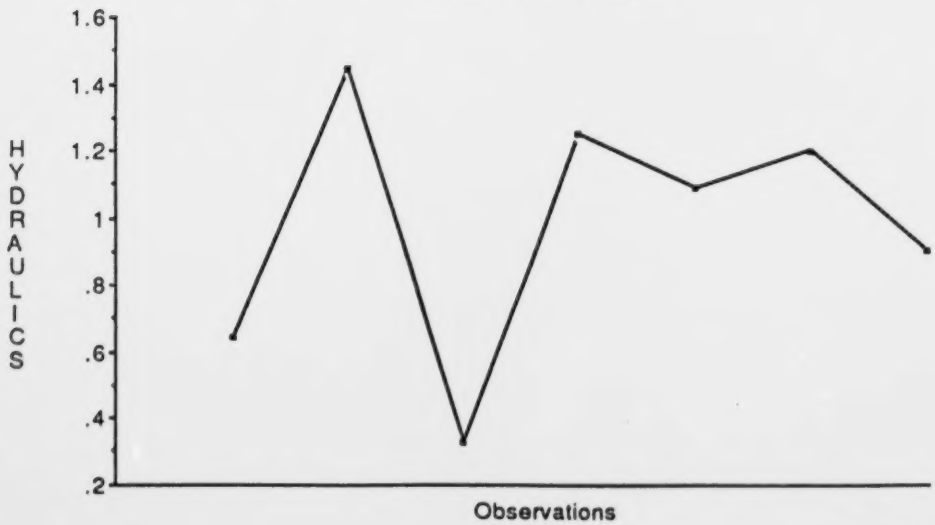
Pie Chart of HYDRAULICS



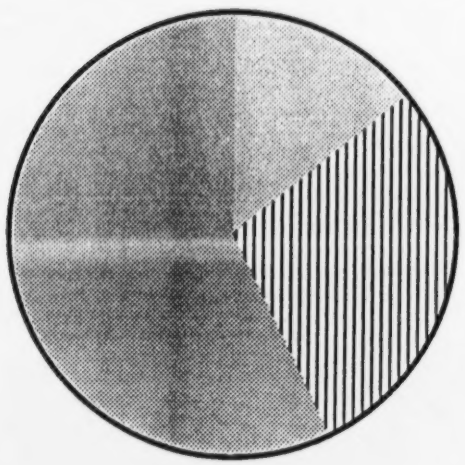
HYDRAULICS

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.333	.704	2	28.571	
2	.704	1.074	1	14.286	
3	1.074	1.445	4	57.143	-Mode

Line Chart of HYDRAULICS



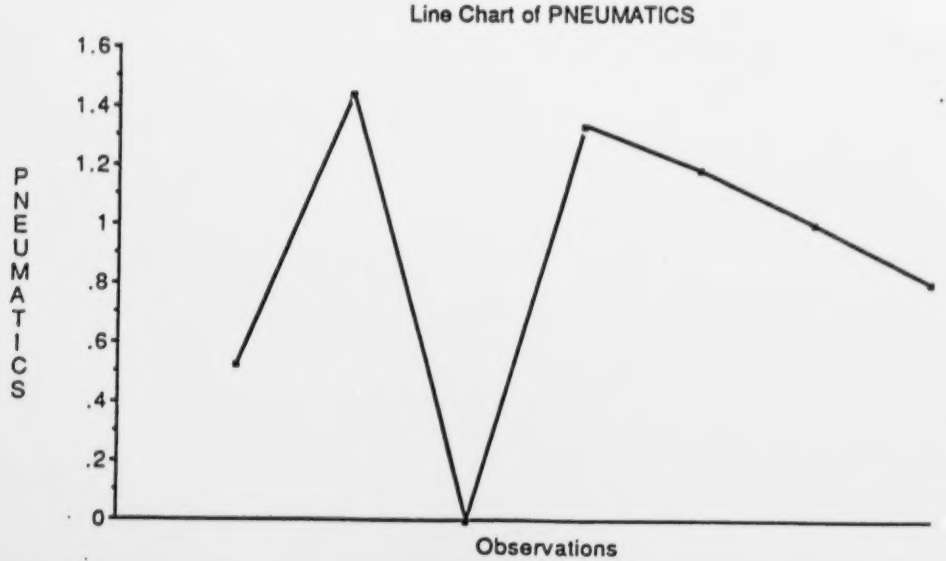
Pie Chart of PNEUMATICS



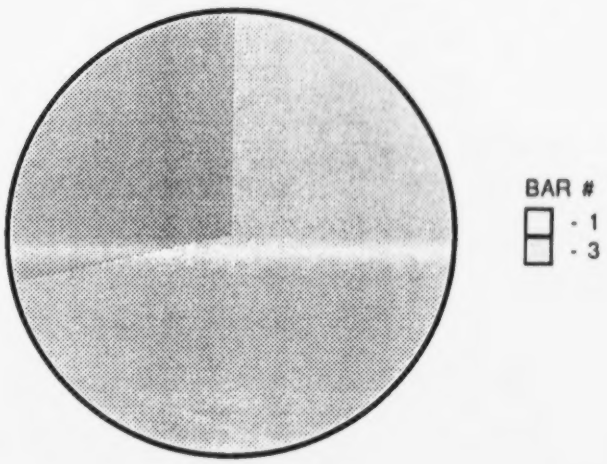
PNEUMATICS

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	0	.482	1	14.286	
2	.482	.963	2	28.571	
3	.963	1.445	4	57.143	-Mode

Line Chart of PNEUMATICS



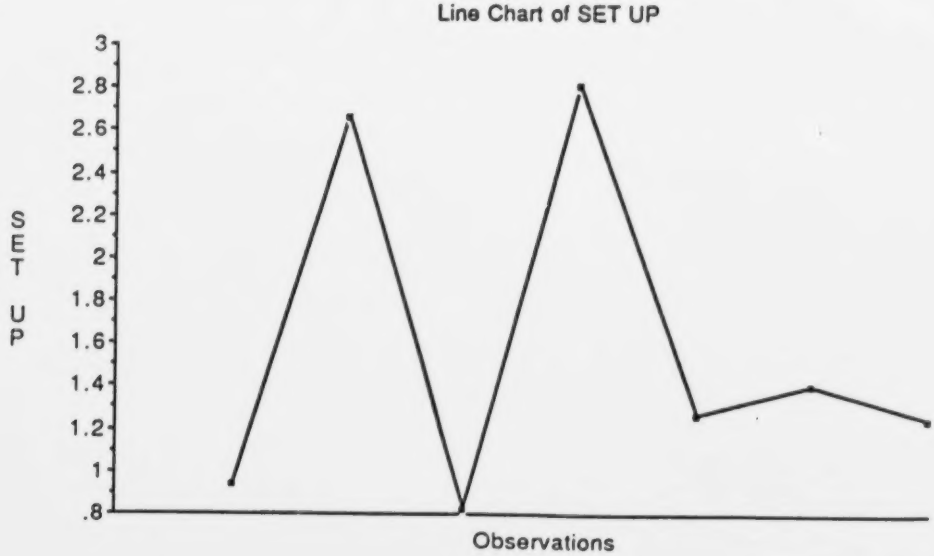
Pie Chart of SET UP



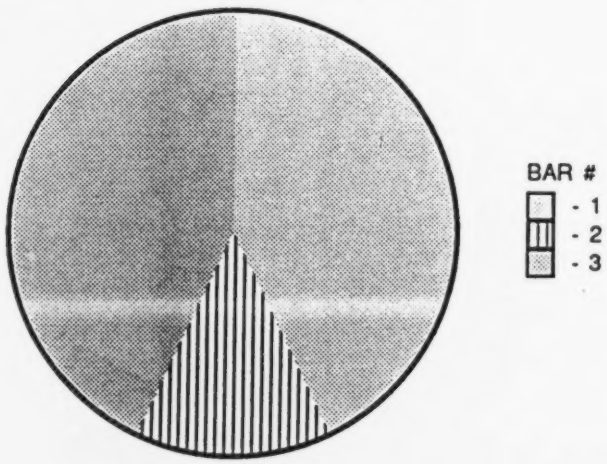
SET UP

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.833	1.495	5	71.429	-Mode
2	1.495	2.157	0	0	
3	2.157	2.819	2	28.571	

Line Chart of SET UP



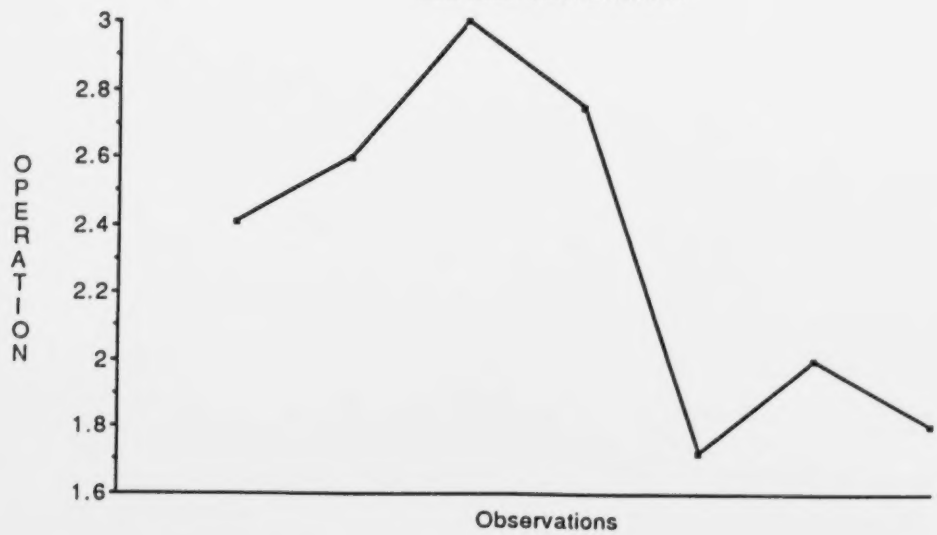
Pie Chart of OPERATION



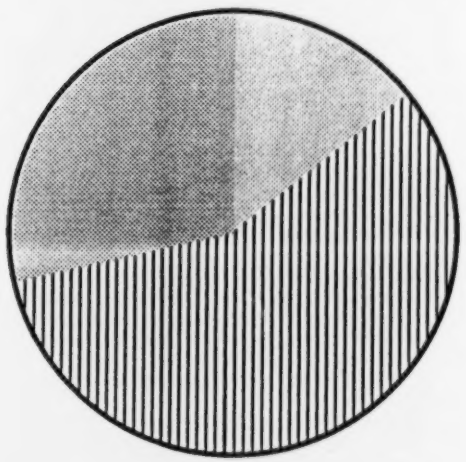
OPERATION

Bar:	From: (≥)	To: (<)	Count:	Percent:
1	1.727	2.152	3	42.857
2	2.152	2.576	1	14.286
3	2.576	3.001	3	42.857

Line Chart of OPERATION



Pie Chart of MAINT&REPAIR



MAINT&REPAIR

Bar:	From: (≥)	To: (<)	Count:	Percent:	
1	.714	1.199	1	14.286	
2	1.199	1.683	4	57.143	-Mode
3	1.683	2.168	2	28.571	

Line Chart of MAINT&REPAIR